SEWAGE AND INDUSTRIAL WASTES

JOURNAL of the FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

Special Features

Trickling Filter Hydraulics—Bloodgood et al.

Rapid Tax Amortization—Flannery

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Petrochemical Wastes—Ruggles

Short-Term BOD—Orford and Matusky

Operator's Corner

1958 Sewer Maintenance Panel

1959 YEAR BOOK AND SUPPLEMENTAL DIRECTORY

MARCH 1959—VOL. 31, No. 3

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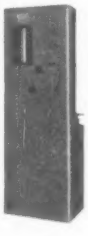

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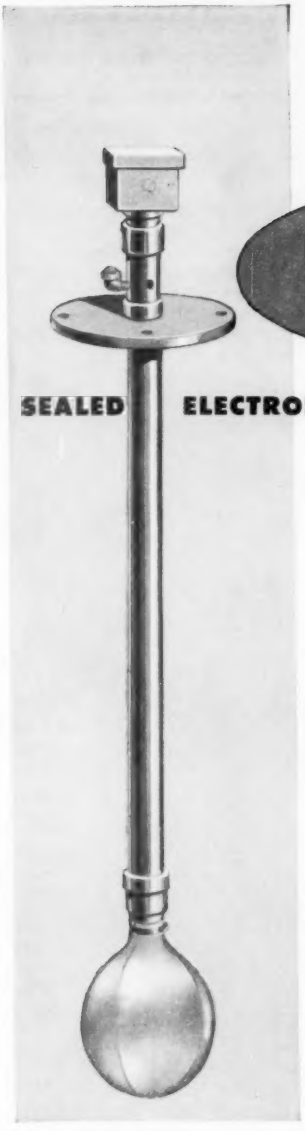

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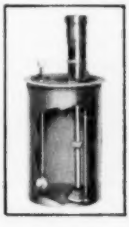

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SEWAGE AND INDUSTRIAL WASTES

Journal of the Federation of Sewage and Industrial Wastes Associations

Volume 31 | March 1959 | Number 3

Contents

Sewage Works

Fundamental Hydraulic Principles of Trickling Filters. By Don E. Bloodgood, G. H. Teletzke, and F. G. Pohland 243

Effects of Magnetic Stirring on the Dropping-Mercury Electrode. By Chris Potos 254

Comparisons of Short-Term with 5-Day BOD Determinations of Raw Sewage. By H. E. Orford and F. E. Matusky 259

Industrial Wastes

Water Resources and Industrial Management. By W. H. Schuette 268

Basic Petrochemical Processes as Waste Sources. By W. L. Ruggles 274

Rapid Tax Amortization for Industrial Waste Treatment Facilities. By James J. Flannery 282

Stream Pollution

The Ontario Water Resources Program. By A. E. Berry 288

The Toxicity of Synthetic Detergents and Soaps to Fish. By C. Henderson, Q. H. Pickering, and J. M. Cohen 295

The Operator's Corner

Sewer Maintenance—Panel Discussion:

I. Records and Permits. By Grant M. Olewiler 307

II. Public Relations and Safety. By M. B. Nixon 309

III. Sewer Repairs. By John L. Klamm 312

Deeds and Data. Highlights from the Annual Reports of Alexandria, Va., Cincinnati, Ohio, Sonoma Valley County, Calif., Toledo, Ohio, and Union City, Tenn. 315

Explosion Prevention. By John R. Wolfs 321

Tips and Quips 323

Editorial

Annual Operating Reports 325

Reviews and Abstracts 326

Constitution and Bylaws 327

1959 Annual Year Book and Supplemental Directory

Officers, Awards, Meetings and Committees 336

Membership Summary 353

Member Associations 354

Honorary Members 359

Associate Members 360

Supplemental Membership Directory 361

Proceedings of Member Associations

Canadian Institute on Sewage and Sanitation 110a

New England Sewage and Industrial Wastes Association 114a

South Carolina Water and Sewage Works Association 116a

West Virginia Sewage and Industrial Wastes Association 118a

Equipment and Supply Lines 121a

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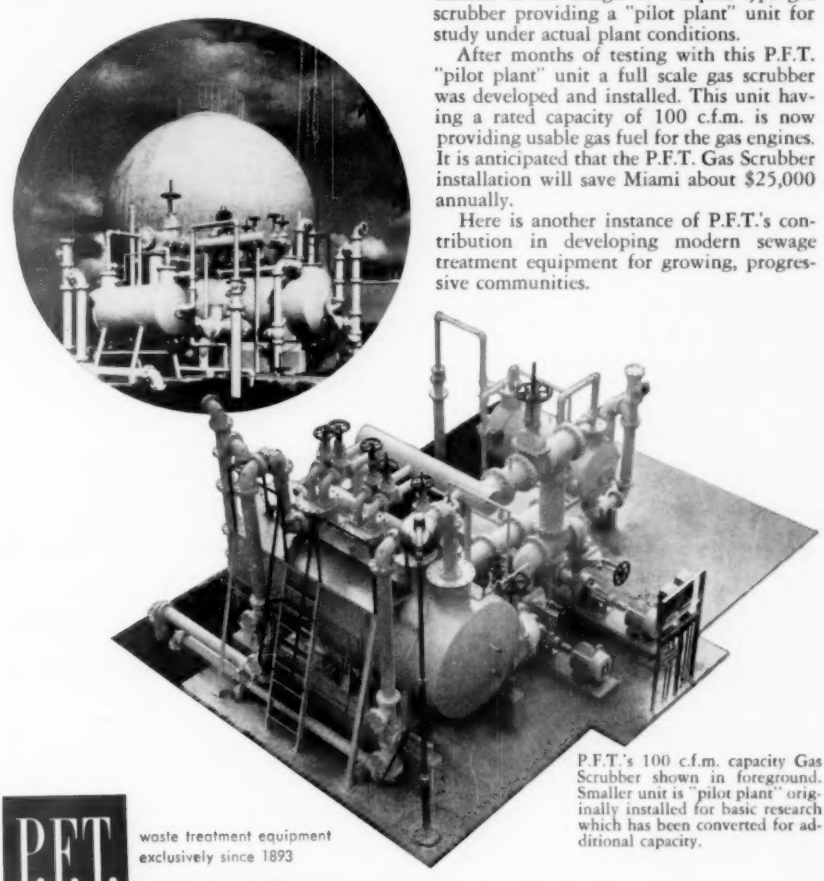

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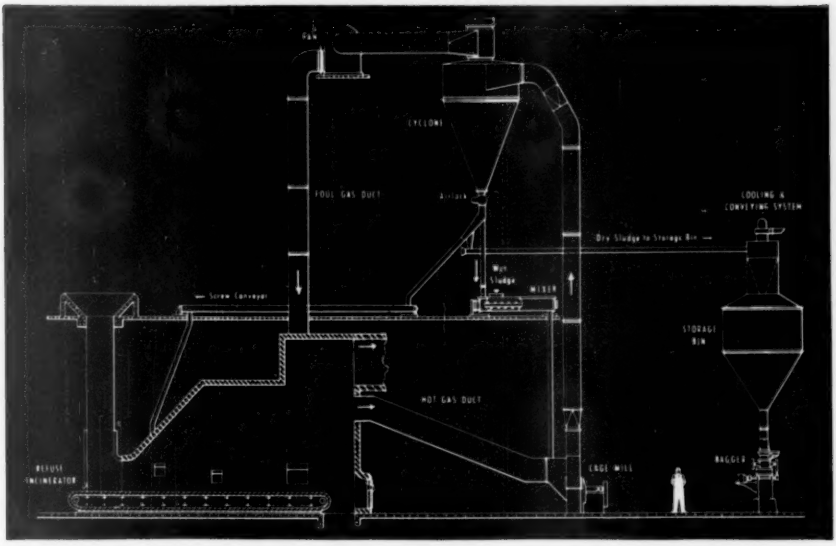

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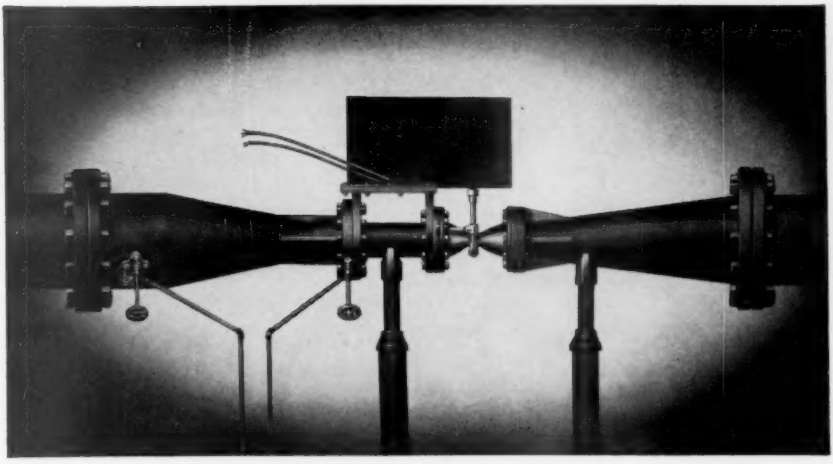

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Mississippi Sewage and Industrial Wastes Assn.	Robert E. Lee Hotel Jackson, Miss.	Mar. 6, 1959
New Jersey Sewage and Industrial Wastes Assn.	Traymore Hotel Atlantic City, N. J.	Mar. 11–13, 1959
Arkansas Water and Sewage Conf.	Marion Hotel Little Rock, Ark.	Mar. 16–18, 1959
Louisiana Conf. on Water Supply and Sewerage	Louisiana State Univ. Baton Rouge, La.	Mar. 18–20, 1959
Montana Sewage and Industrial Wastes Assn.	Jordan Hotel Glendive, Montana	Apr. 9–11, 1959
Virginia Industrial Wastes and Sewage Works Assn.	The Mimslyn Luray, Va.	Apr. 13–14, 1959
Arizona Sewage and Water Works Assn.	Hi-Way House Hotel Phoenix, Ariz.	Apr. 16–18, 1959
Kansas Sewage and Industrial Wastes Assn. (*Change in Location*)	Besse Hotel Pittsburg, Kans.	Apr. 22–24, 1959
California Sewage and Industrial Wastes Assn.	Lafayette Hotel Long Beach, Calif.	Apr. 29– May 2, 1959
Iowa Sewage and Industrial Wastes Assn.	Roosevelt Hotel Cedar Rapids, Iowa	June 17–19, 1959

THIRTY-SECOND ANNUAL MEETING

Federation of Sewage and Industrial Wastes Associations
Host—Sewage and Industrial Wastes Section,
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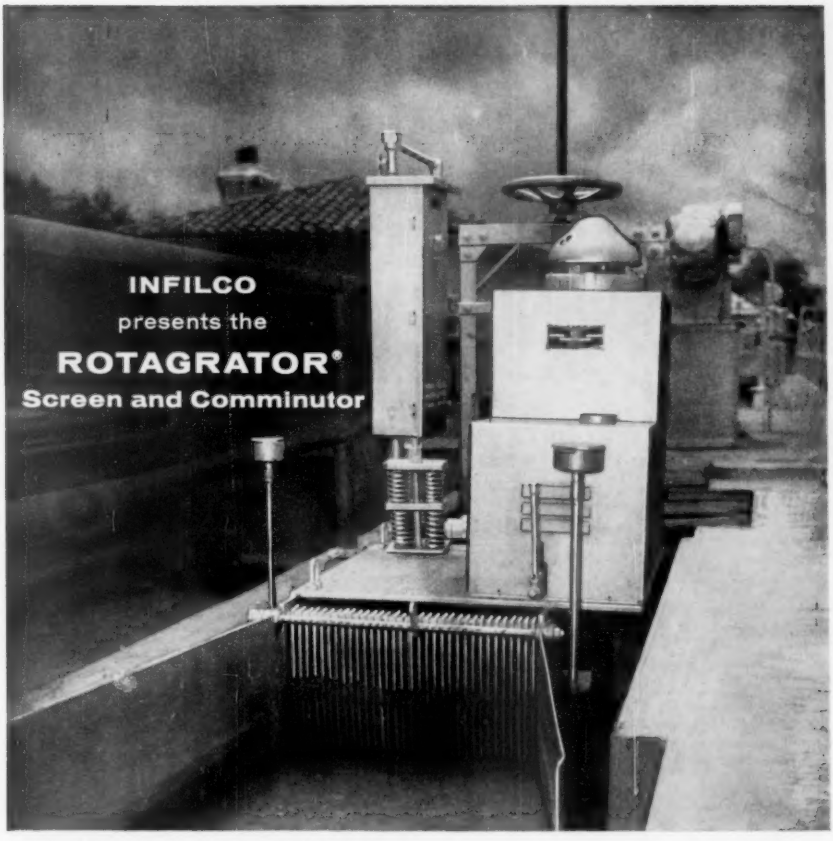
Statler Hilton Hotel, Dallas, Texas

Technical Meetings and Exhibits—Dallas Memorial Auditorium
October 12–15, 1959



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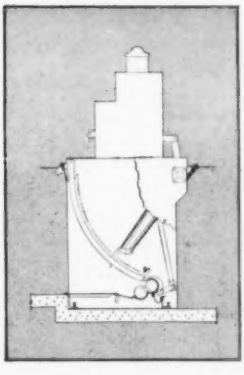

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Field offices throughout the United States and in foreign countries.

The ONLY Company IMPARTIALLY offering equipment for ALL types of water and waste processing—coagulation, precipitation, sedimentation, flotation, filtration, ion exchange and biological treatment.

BIG AD CAMPAIGN WARNS OF GROWING WATER PROBLEM!

Urges local support for better water systems

Cast Iron Pipe Research Association offers local plan-of-action booklet

Here's help for you and everyone else directly concerned with the supply, treatment and distribution of water—help that will acquaint the people in your town with the vital importance of this growing problem.

On the opposite page you see the second in a series of advertisements, this one appearing in April *Reader's Digest*. Placed by the Cast Iron Pipe Research Association, these striking advertisements point out to Mr. and Mrs. America how much we depend on a good water system and why we can no longer take it for granted.

Similar advertising will appear regularly in *U. S. News & World Report*, *Nation's Business*, *Better Homes & Gardens*, *American Home* and *Sunset* magazines to carry this public service message to millions of civic leaders and homeowners.

Free Local How-to-Help Booklet

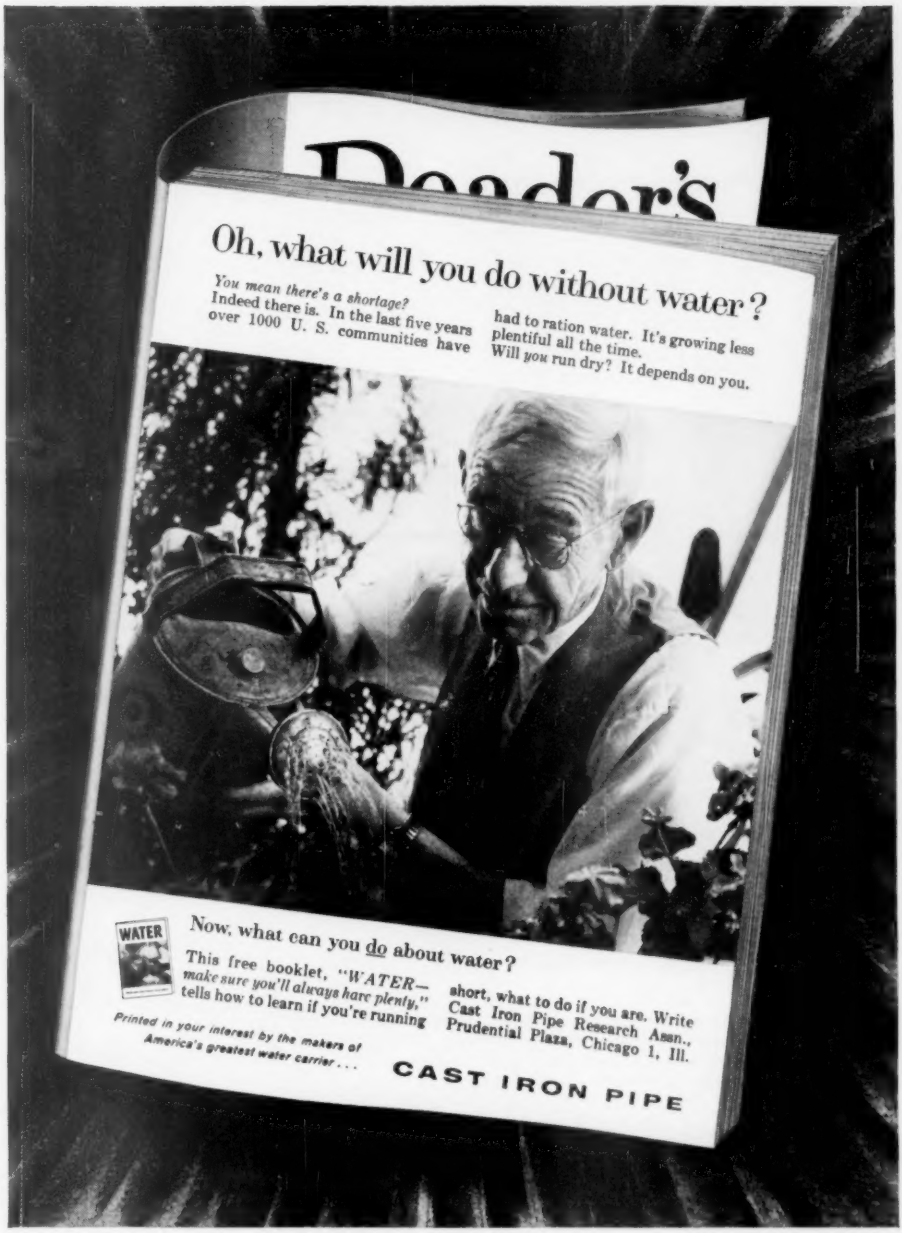
These ads offer a free booklet telling about the water problem. It shows how responsible citizens can acquaint themselves with the needs of their community. It also gives a step-by-step outline of action, telling how they can help their officials extend and improve the local water system through more adequate rate structures or financing.

Let us send you a free copy of this new booklet. Write to Thos. F. Wolfe, Managing Director, Cast Iron Pipe Research Association, 3440 Prudential Plaza, Chicago 1, Ill.

Three reasons why cast iron pipe is America's greatest water carrier:

1. More miles of underground cast iron water mains are now in use than of all other kinds of pipe combined.
2. More miles of cast iron water mains are now being purchased and laid than of any other kind of pipe.
3. Impartial surveys prove that today's consulting engineers and water utility officials prefer cast iron pipe for underground water distribution by an overwhelming majority.

CAST IRON PIPE


Reader's
Oh, what will you do without water?
You mean there's a shortage?
Indeed there is. In the last five years over 1000 U. S. communities have had to ration water. It's growing less plentiful all the time.
Will you run dry? It depends on you.
WATER
Now, what can you do about water?
This free booklet, "WATER—make sure you'll always have plenty," tells how to learn if you're running short, what to do if you are. Write Cast Iron Pipe Research Assn., Prudential Plaza, Chicago 1, Ill.
Printed in your interest by the makers of America's greatest water carrier . . .
CAST IRON PIPE

Carter Equipment

for the treatment of

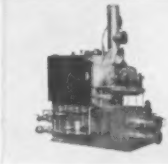
water, sewage and industrial wastes

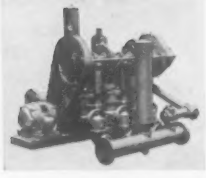
CLARIFIERS

ROTARY DISTRIBUTORS

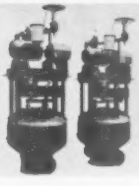
FLOATING ROOF DIGESTERS

SLUDGE HEATERS





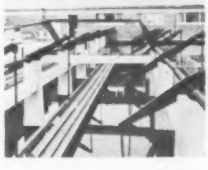
SLUDGE PUMPS



PNEUMATIC EJECTORS

for the Engineer who demands the finest!

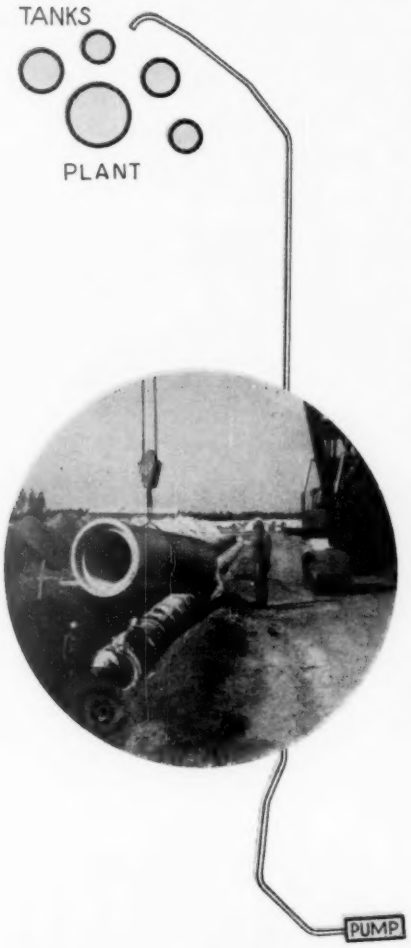
Thousands of installations throughout the world are proving the careful engineering and workmanship that go into Carter Equipment. Experienced engineering-sales representatives are located in every area of the United States and in principal cities overseas . . . ready to serve you.



FLOCCULATION EQUIPMENT

RALPH B. CARTER COMPANY
200 ATLANTIC STREET, HACKENSACK, NEW JERSEY

the problem...



Problem: Move 30,000 gallons of sea water per minute through aggressive soil and ground water.

The Project: Magnesium-oxide plant for Michigan Chemical Company at Port St. Joe, Fla.

The Engineer: Cunningham-Limp Company, Detroit, Mich.

The Solution: 36″ diameter Cen-Vi-Ro Water Pipe made with sulphate resisting Portland Cement and limestone aggregate; two inches of concrete cover for the reinforcing steel; six inches of loose oyster shell all around the pipe.

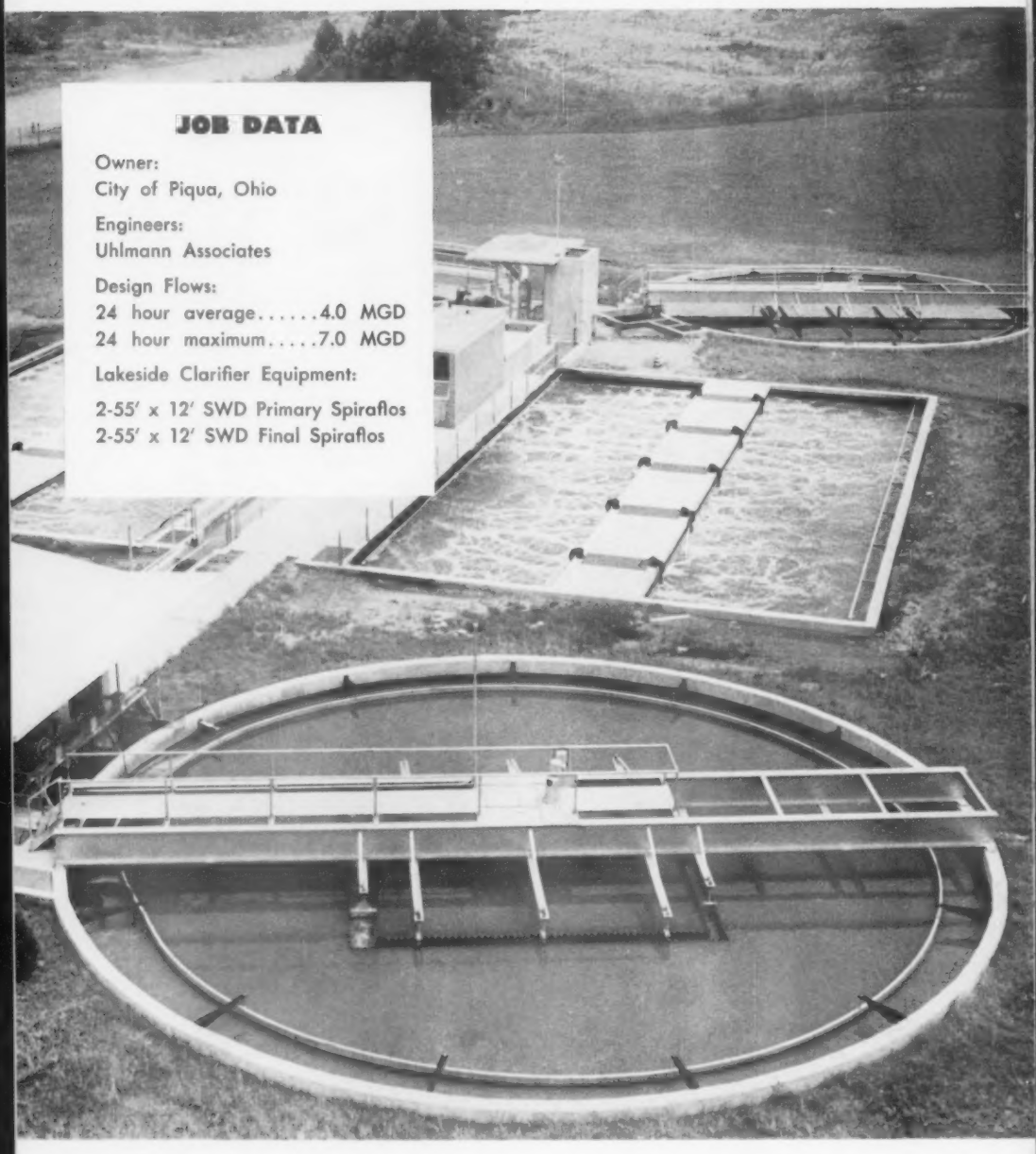
The Result: Service life estimated at more than 50 years.

Cen-Vi-Ro Pipe . . . engineered and made to your specifications . . . serves you better. When your job calls for concrete pipe, call Concrete Pipe Division, Vulcan Materials Company, Atlanta, Georgia.

CONCRETE PIPE DIVISION

VULCAN MATERIALS COMPANY

P.O. Box 6226, Station H, Atlanta, Georgia • JAckson 4-6244



JOB DATA

Owner:
City of Piqua, Ohio

Engineers:
Uhlmann Associates

Design Flows:
24 hour average.....4.0 MGD
24 hour maximum.....7.0 MGD

Lakeside Clarifier Equipment:

2-55′ x 12′ SWD Primary Spiraflos
2-55′ x 12′ SWD Final Spiraflos

SPIRAFLOS—give high removals as both primary and final settling tanks—ideal as finals on activated sludge because of the added depth and the flow pattern that traps the light activated particles in the sludge blanket build up. Also a perfect clarifier for the smaller plants particularly where efficient skimming and scum removal are desired.

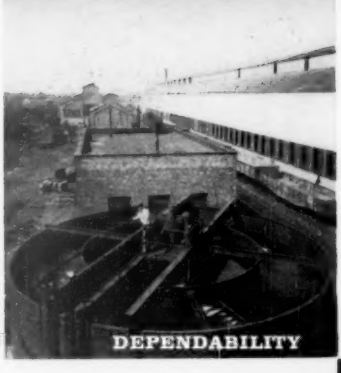
LAKESIDE

ENGINEERING CORPORATION
222 West Adams St., Chicago 6, Illinois

SAVINGS

SIMPLICITY

IN WASTE TREATMENT FOR EVERY INDUSTRY



DEPENDABILITY

GRAVER Offers

SAVINGS • SIMPLICITY • DEPENDABILITY

SAVINGS in a tissue mill. Over $7,000 a month saved on recovered pulp fiber and recovered water. White water treatment uses Graver flotation equipment.

SIMPLICITY in a missile plant. Plating of missile parts requires over 10 processes resulting in chrome, cyanide, acid and alkali wastes. These wastes are collected from 120 plating tanks into three streams and treated by an integrated Graver plant providing for destruction and reduction of wastes. Central control board, simple operating charts keep operator time to a minimum.

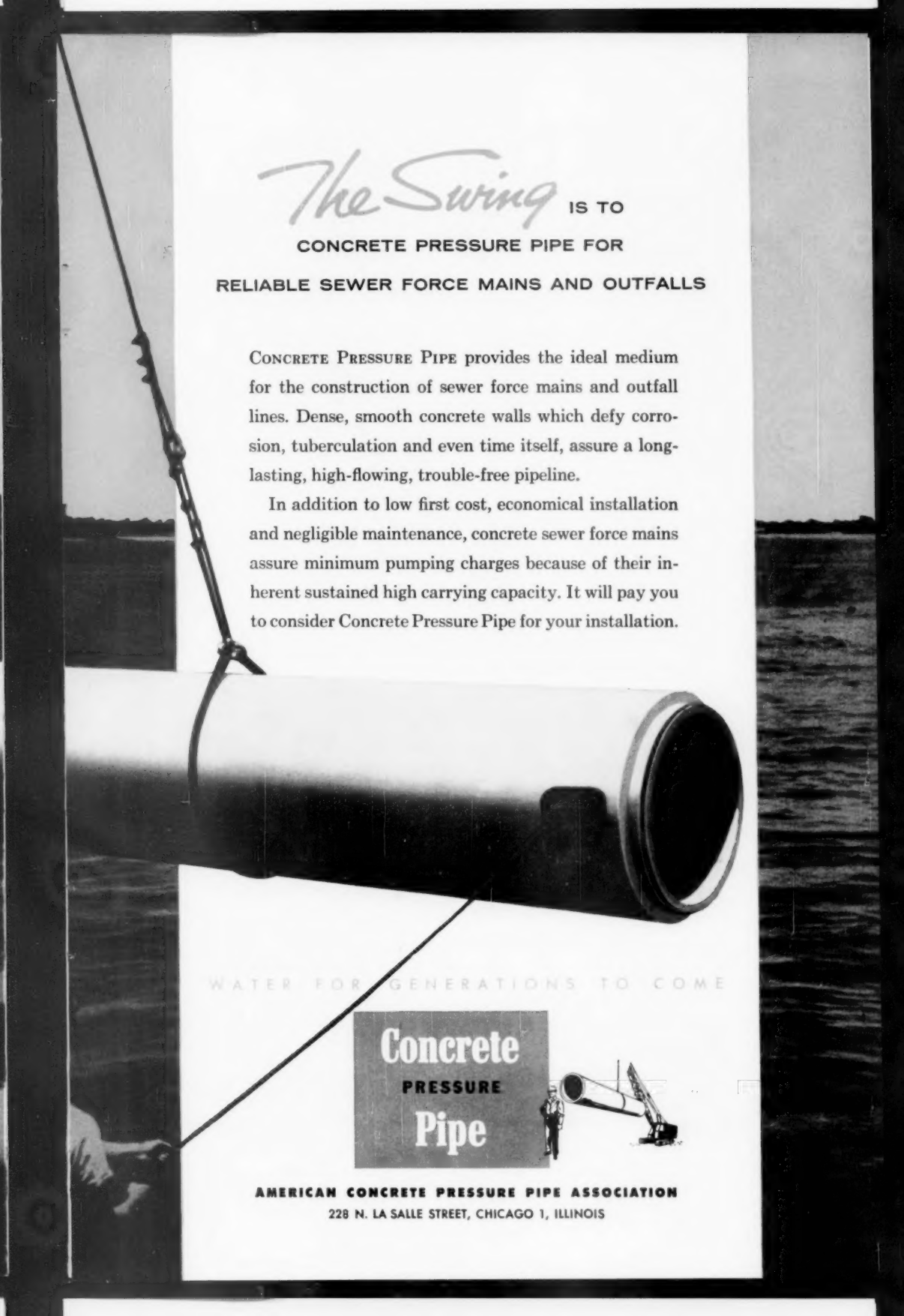
DEPENDABILITY in a steel plant. Specially designed clarifier, installed in 1944 effectively treats flotable and settleable material in oily wastes from steel production. Unit meets all requirements of plant as it has done since the time it was installed 14 years ago.

Your waste treatment plant can incorporate all three advantages. Perhaps no recovery is possible or desirable at your plant, yet you still get simplicity and dependability and save because of them through low requirements on equipment, time, labor and maintenance. Perhaps automatic operation is not indicated, yet with Graver you still get the simplest operating plant possible plus the other advantages. Graver offers equipment for all types of waste treatment in a wide range of industries. Our experience and the high quality design and construction of our units assure the most advantages in your waste treatment plant.

Request literature! Tell us the industry you are interested in or the problem you have, and we will send you case history studies of how problems were solved and how individual plants, representative of many, benefited from Graver's trio of advantages — savings, simplicity and dependability.

GRAVER

Industrial Waste Treatment Dept. W-522
GRAVER WATER CONDITIONING CO.
Division of Union Tank Car Company
216 West 14th Street, New York 11, N. Y.



The Swing IS TO

CONCRETE PRESSURE PIPE FOR

RELIABLE SEWER FORCE MAINS AND OUTFALLS

CONCRETE PRESSURE PIPE provides the ideal medium for the construction of sewer force mains and outfall lines. Dense, smooth concrete walls which defy corrosion, tuberculation and even time itself, assure a long-lasting, high-flowing, trouble-free pipeline.

In addition to low first cost, economical installation and negligible maintenance, concrete sewer force mains assure minimum pumping charges because of their inherent sustained high carrying capacity. It will pay you to consider Concrete Pressure Pipe for your installation.

WATER FOR GENERATIONS TO COME

Concrete
PRESSURE
Pipe

AMERICAN CONCRETE PRESSURE PIPE ASSOCIATION

228 N. LA SALLE STREET, CHICAGO 1, ILLINOIS

COMPLETE LINE to Meet Your Exact Needs

Including many Exclusive Developments

Utilize our many years of experience in the development and manufacture of municipal and industrial waste treatment equipment. Our staff of engineers is ready to cooperate with consulting and operating engineers in suggesting the process of treatment and type of equipment best suited to individual needs.

BIO-ACTIVATION—exclusive system combines best qualities of trickling filter and activated sludge. *Bulletin 259B.*

MECHANICALLY CLEANED SCREENS AND GRINDER—with intermittent automatic control. *Design data in Technical Supplement MS.*

GRIT CHANNELS—exclusive Camp Chamber design and Regulator permit easy and instant variation in velocity. *Design data in Technical Supplement CR.*

GRIT SETTLERS—with conveyor, elevator, and exclusive Hydrowash unit which removes grease and organic matter from grit. *Bulletin 249B.*

GREASE FLOTATION UNIT—removes grease and oils, produces simultaneous aeration and agitation, and oxidizes objectionable odors. *Bulletin 260B.*

SLUDGE COLLECTORS—for rectangular and circular tanks . . . flight type and helicoid cross conveyors . . . sludge valves. *Bulletin 253B and Technical Supplement TV.*

AERATORS—downflow mechanical air diffusion type provides thorough and adjustable oxygenation and circulation of liquor. *Bulletin 265A.*

JET AERATION—exclusive method produces an unprecedented rate of oxygen absorption. *Bulletin 265A.*

ROTARY DISTRIBUTORS—reaction and positive drive types with exclusive trouble-free oil seal. *Design data in Technical Supplement RD.*

DOWNFLO FLOCCULATION UNIT—for slow mixing and flocculation of chemicals in sewage treatment processes. *Design data in Technical Supplement PF.*

SEWAGE AND SLUDGE PUMPS—horizontal and vertical pumps in wide range of sizes, capacities and heads—including cutting type primary sludge pumps, enclosed impeller type sewage pumps, single vane impeller type sewage pumps and recirculation pumps. **Send for Bulletins.**

Send for informative bulletins listed above.

Inquiries on new installations or improvements of existing plants will receive prompt attention.

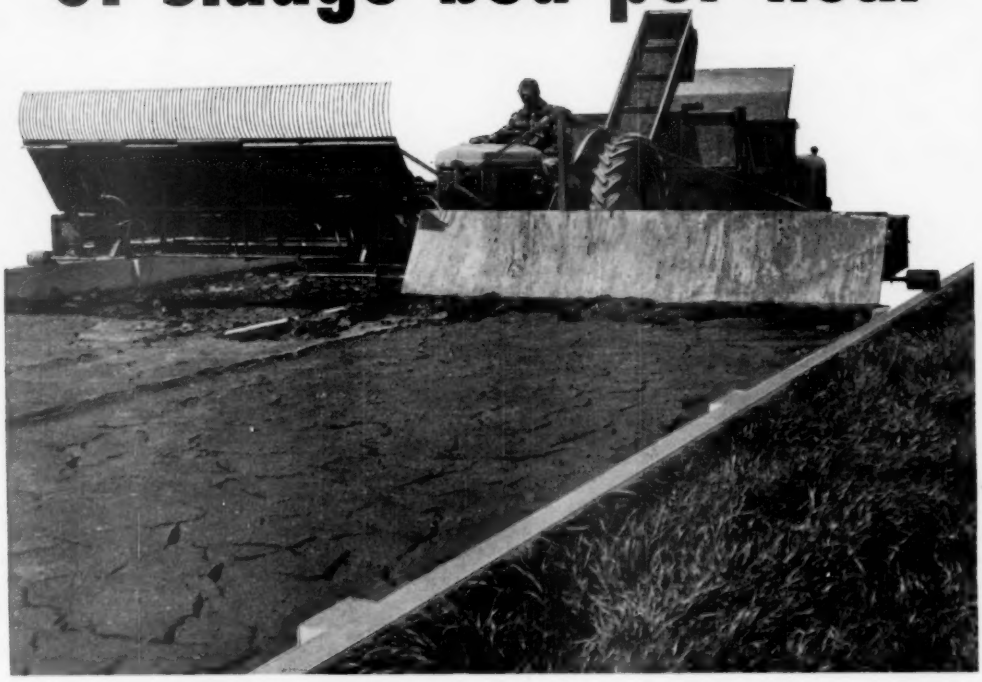
AMERICAN WELL WORKS

IN OUR 81ST YEAR
110 North Broadway
AURORA, ILLINOIS

Pumping, Sewage Treatment, and Water Purification Equipment
RESEARCH • ENGINEERING • MANUFACTURING

Offices: Chicago • New York • Cleveland • Cincinnati • Kansas City • Sales Representatives throughout the World

Cleans up to 120 feet of sludge bed per hour



Mechanical cleaner provides faster and more efficient sludge removal than conventional hand cleaning methods

Here's a mechanized method of cleaning sludge beds that will pay for itself in a relatively short time. While individual savings depend on such variables as size of plant, available manpower, method of disposal, etc., annual savings of 60% have been reported over conventional hand cleaning.

The sludge bed cleaner offered by Link-Belt is essentially a conveyor system on wheels . . . the system is mounted on a standard tractor, which travels on concrete runways in sand beds and cleans a path up to 26 feet in width. Performance-proven Link-Belt conveying and power transmission components are combined into an efficient mechanism that is operated by hydraulic motors.

The cleaning cycle works like this. Forked scoops assure minimum loss of filter bed sand. The scoops are raised alternately, elevating the sludge and chuting it over a front truss. Sludge is conveyed by two wing conveyors into a trough where it is pushed along by a center longitudinal flight conveyor. This conveyor carries the sludge up a 45° incline where it is deposited in a truck that is towed or driven behind the tractor.

For more detailed information on how you can clean sludge beds faster, more efficiently, call your nearest Link-Belt office. Send for Folder No. 2671.

LINK-BELT

SANITARY ENGINEERING EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. Sanitary Engineering Regional Offices—Colmar, Pa., Chicago 9, Kansas City 8, Mo., San Francisco 24. Sales Offices in All Principal Cities. Export Office, New York 7. Representatives Throughout the World. 14,902

3 top contractors tell how **Transite Sewer Pipe** helped keep installation costs low on the Allegheny County Sanitary Authority sewage project (Allegheny County, Pa.)

"Transite saved us considerable labor especially when we were working in 18- to 28-foot trenches . . ."

says W. R. Davies, W. R. Davies Company
Pittsburgh, Pennsylvania

"For the Allegheny County Sanitary Authority we used Transite Pipe for Sanitary Sewers because it is faster to install, lighter, and more readily handled than the other materials specified as alternates. Transite saved us considerable labor especially when we were working in 18- to 28-ft. trenches.

"Another part of our 'Authority' contract included the installation of 5,300 feet of Domestic Water and Fire lines at the 150 MGD capacity Pittsburgh Sewage Treatment Plant. We used Transite Pressure Pipe for this entire job. Our costs were low because it is faster to install."

W. R. Davies Co. installation.

"In a remarkably short time, our men installed two miles of Transite . . . even though they worked below the adjacent river level . . . and between railroad tracks and one of the most congested highways in the county . . ."

says P. A. Benintend, Ben Construction Company
Pittsburgh, Pennsylvania

"For the Allegheny County Sanitary Authority Contract, Transite's ease of installation . . . sure coupling . . . and 13-foot lengths saved money for us in over-all installation. In a remarkably short time, our men installed two miles of Transite Sewer Pipe and force mains, even though they worked below the adjacent river level to install the force main—and between railroad tracks and one of the most congested highways in the county to install the sewer. Speed of installation plus prompt delivery enabled us to finish the job well before the required completion date."

"We installed Transite Sewer Pipe in some of the toughest locations on this job."

says D. C. Rothey, Project Manager
Harrison Construction Company
Pittsburgh, Pennsylvania

"In our stretch down along the Allegheny River we were constantly 5 to 14 feet below normal pool stage level. Final inspection revealed no infiltration."

Transite Sewer Pipe installations on the $100-million Allegheny County Sanitary Authority Project. Shown here is part of Harrison Construction Co. contract.

Ben Construction Co. installation.

How TRANSITE PIPE answers your two most important problems in sewer installation and operation!

IN INSTALLATION, your big problem is time. For the longer it takes to complete a "tight" installation the more it costs . . . the more annoying the problem of torn-up, detoured streets. And this is where Transite® pays its way in time-saving alone. Its lightweight, long lengths and quickly, *surely* assembled Ring-Tite® Coupling speed every step of installation.

In operation, infiltration and root-clogging can be even more costly. But they're problems that Transite's Ring-Tite® Coupling was designed to solve. Rubber sealing rings, tightly compressed between sleeve and pipe, give you a tight, long-lasting joint that locks out roots . . . seals out unwanted ground water.

Let us send you booklet TR-165A. Address Johns-Manville, Box 14, New York 16, N. Y.

JOHNS-MANVILLE JM JOHNS-MANVILLE PRODUCTS

INERTOL PAINTS PROTECT
MULTI-MILLION-DOLLAR MIAMI PLANT

Partial view of new Sewage Treatment Plant, City of Miami, Florida . . . buildings, tanks, equipment . . . protected with Inertol Paints.

On Virginia Key, three miles off the Florida mainland, stands Miami's new $10-million sewage treatment plant, heart of the new $27-million sewerage system. To protect this costly installation against the ravages of corrosion, fumes, condensation, salt air, heat and humidity, rugged Inertol coatings were specified (Consulting Engineers: Metcalf and Eddy, Boston, Massachusetts).

Buildings, the four 105′-diameter digesters, the towering chimney structure and other surfaces are protected economically and efficiently with *Ramuc® Masonry Paint.* Thousands more square feet of area of this 47-MGD plant are guarded with other corrosion-resistant, attractive Inertol coatings.

Buy Inertol paints direct from the manufacturer. Shipment within three days from our plant, or from nearby warehouse stocks. Write for free booklet S-754, "Principal Types of Protective Coatings."

SPECIFICATIONS FOR RAMUC MASONRY PAINT

A chlorinated natural rubber-base paint in color. Flat finish. For exterior above-grade masonry. Unaffected by masonry lime. Highly weather- and fume-resistant. No mottling.

Colors: Color Chart 563.
No. of coats: Two (if semi-gloss finish desired, specify semi-gloss type for top coat).
Coverage: 150-250 sq. ft. per gal. per coat, depending on surface texture.
Approx. mil thickness per coat: 1.5.
Drying Time: 24 hours.
Primer: None. However, to minimize efflorescence, specify one coat of Pluvol* as primer.
Thinners: Inertol Thinner 2000-A for brushing; 2000, for spraying.
Application: Brushing: As furnished. Spraying: First coat must be brushed. For spraying, add sufficient Thinner 2000 (10-15%).

*Registered Trademark. *Write for information on Pluvol, invisible silicone water-repellent.*

A complete line of quality coatings for sewage, industrial wastes and water plants.

Inertol®

INERTOL CO., INC.

482 Frelinghuysen Ave., Newark 12, N. J. • 27-H South Park, San Francisco 7, Calif.

MADISONVILLE, KY., has had no property taxes for three successive years. With this record of efficient management, it is only natural that Clay Pipe should be chosen for the city's new sewerage expansion system. More than twenty-two miles of Vitrified Clay Pipe are going into the project.

Clay Pipe was the natural choice because it does not rust, rot, corrode, or disintegrate . . . never wears out. And new, longer, stronger lengths speed installation . . . cut labor costs.

Only Clay Pipe has *all* the features you can trust.

Public Officials: David Parish, Mayor; A. O. Johnston, Councilman, Chairman of Water and Sewers.

Consulting Engineers: J. Sanders Parker; F. E. Stepp, Resident Engineer.

Contractors: C.F.W. Construction Co., Inc.; Sterrett Construction Co.

C-458-1A

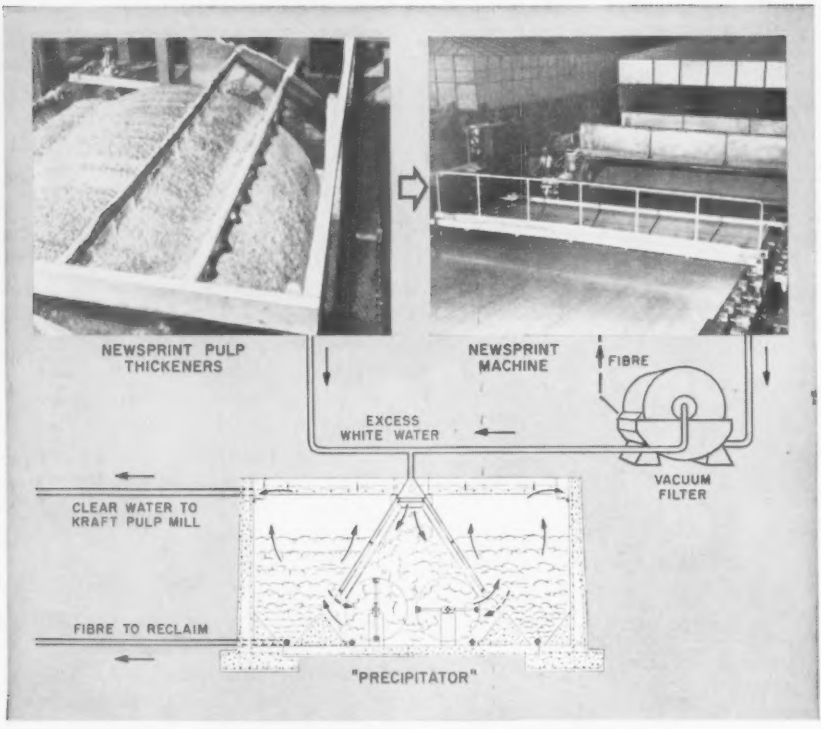
Vitrified **CLAY PIPE** *Never Wears Out*

NATIONAL CLAY PIPE MANUFACTURERS, INC.

1820 N St. N. W., Washington 6, D. C.

311 High Long Bldg., 5 E. Long St., Columbus 15, Ohio • 703 Ninth & Hill Bldg., Los Angeles 15, Calif.

Box 172, Barrington, Illinois • 1401 Peachtree St., N. E., Atlanta 9, Georgia



Southland Paper recovers fiber, solves disposal problem with a "Precipitator"

Southland Paper Mills are pumping effluent loaded with fiber from their groundwood mills and newsprint savalls to a Permutit *Precipitator.*

The *Precipitator* removes the suspended solids. Then, the real savings begin. The mill blends the clarified effluent with fresh water and uses it as make-up in the kraft mill. The reclaimed fiber is returned to process as No. 1 quality groundwood for newsprint.

Flexible. You can get flows as high as 50% over design capacity or as low as 80% below design without losing the blanket on a *Precipitator.*

Expansible. You can run *Precipitators* in series, often off the same drive. One mill went from 15,000 to 27,000 gpm with no loss of space between units.

Call our Permutit Division whenever you have a waste-treatment problem and get the advantages of engineering experience with all major types of waste-separation equipment, including precipitation and flotation units, centrifuges, filters, evaporators, and degasifiers. Address inquiries to Permutit Division, Dept. SI-39, 50 West 44th St., New York 36, N. Y.

PFAUDLER PERMUTIT INC.

Specialists in FLUIDICS . . .
the science of fluid processes

Specify
IOWA
for every job
Iowa's complete line of valves for treatment plants assures you of efficient operation, low maintenance cost, and replacement parts when needed in years to come.

IOWA CHECK VALVES—Swing gate type for use in either horizontal or vertical pipe lines. Bronze trimmed throughout. Stainless steel hinge pins. Leather or rubber faced gates, or solid bronze, as desired—aluminum gates available for air service.

IOWA MEDIUM AND LOW PRESSURE VALVES—either non-rising stem or outside screw and yoke types. Designed as carefully as those conforming to A.W.W.A. specifications but with lighter construction for lower pressures.

Write TODAY for descriptive literature

IOWA FLAP VALVES—all iron; can be furnished with bronze hinge bolts or fully bronze mounted—including bronze bolts, flap ring and seat ring—when required.

CLOW HYDROSTATIC RELIEF VALVES — commonly used in bottom of concrete tanks to prevent ground water from floating the tank. Close-grained cast iron body and lid; lead seat ring and lid ring. Cast iron grate in bottom prevents foreign matter from entering tank.

IOWA PLUG DRAIN VALVES—either rising or non-rising stem type. High strength cast iron bodies; bronze stem, operating nut, disc ring and seat ring; rustproof steel bolts and nuts. Handwheels, extension stems, plain or indicating floor stands if required.

IOWA SLUICE GATES—can be used in lines having both seating and unseating pressures. High strength cast iron, bronze mounted, with solid bronze adjustable wedges. Can be equipped with cylinder or motor unit for automatic operation.

IOWA SHEAR GATES—either all iron or iron, bronze mounted. Gate-seating wedges bolted on, permitting replacement without replacing frame.

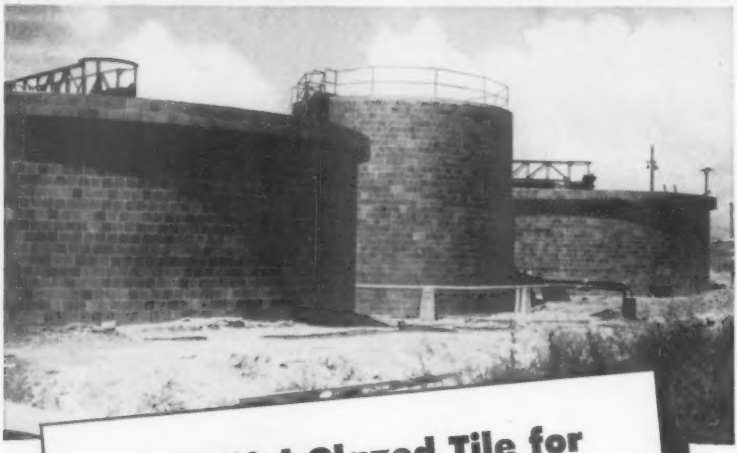
For 50 years a reliable source for precision engineered products

IOWA VALVE COMPANY

A Subsidiary of James B. Clow & Sons

Oskaloosa, Iowa

Effluent and Water Treatment Tanks



Beautiful Glazed Tile for Complete Corrosion Resistance

•

Comparable in Cost to Concrete or Steel... No Continuing Maintenance

Stebbins SEMTILE and SEMBLOCK® tanks are, in effect, reinforced concrete structures faced on both sides with vitrified tile. No form work is required. Contours and dimensions can be varied to fit all types of specialized equipment.

Installations can be made under a contract which covers everything from the original design, based on full knowledge of the chemical, physical and mechanical requirements, to the finished job ready for use.

Write for complete information

SEMCO

STEBBINS Engineering and Manufacturing Company

WATERTOWN, N. Y. • PENSACOLA, FLORIDA

STEBBINS ENGINEERING CORP. — TOWER BLDG., SEATTLE, WASH.

CANADIAN STEBBINS ENGR. & MFG. CO., LTD. — TOWN OF MOUNT ROYAL, MONTREAL 9, CANADA

SINCE 1884

Specialists in Design, Installation and Servicing of Linings and Tile Tanks

"Out of sight—out of mind" can be a mighty expensive philosophy in any water distribution system. The above unretouched photograph proves this point. It shows a badly tuberculated *eight inch* main whose *inside diameter was reduced to an average of almost 4.5 inches.* Resultant higher pumping costs with reduced pressure and carrying capacity make it costly to tolerate such conditions. That is why the savings effected in reduced pumping costs frequently pay for the *low cost* of National water main cleaning.

Since there's never a charge or obligation to inspect your mains, *call National now!*

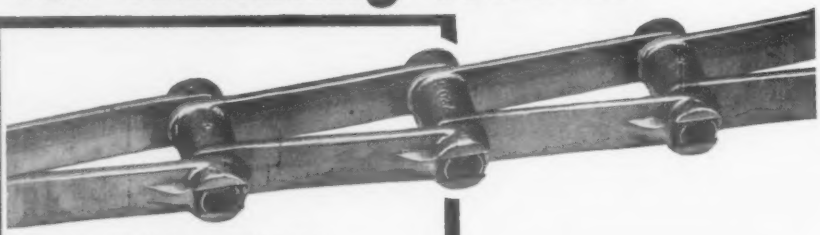
Call in National today!

NATIONAL WATER MAIN CLEANING COMPANY

50 Church Street • New York, N. Y.

ATLANTA 3, GA., 333 Candler Building • BERKELEY, CALIF., 920 Grayson Street • BOSTON 15, MASS., 115 Peterboro Street • CHARLOTTE, N. C., 533 Hollis Road • CHICAGO, ILL., 8 So. Dearborn Street • DECATUR, GA., P. O. Box 385 • EL MONTE, CALIF., 2024 Merced Avenue • FLANDEAU, S. D., 315 N. Crescent Street • KANSAS CITY, MO. 3707 Madison Avenue • MINNEAPOLIS, MINN. 200 Lumber Exchange Building • OMAHA, NEBR., 510 Standard Oil Bldg. • RICHMOND 21, VA., 2910 W. Clay Street • SALT LAKE CITY, UTAH, 502 West 3rd Street • SIGNAL MOUNTAIN, TENN., 204 Slayton Street • VILLA PARK, ILL., 424 S. Yale Avenue • MONTREAL, CANADA, 7445 Chester Avenue • WINNIPEG, MANITOBA, 576 Wall Street • BOGOTA, COLOMBIA, Apartado de Correos #5 • SAN JUAN 10, PUERTO RICO, Manquinaria, Apartado 2184 • LIMA, PERU, Bolivar 441-A, Marafi • CARACAS, VENEZUELA, Apartado 561 • HAVANA, CUBA, P. O. Box 531 • OSLO, NORWAY, Radhusgaten 30

Webster CHAIN
for Handling Wastes

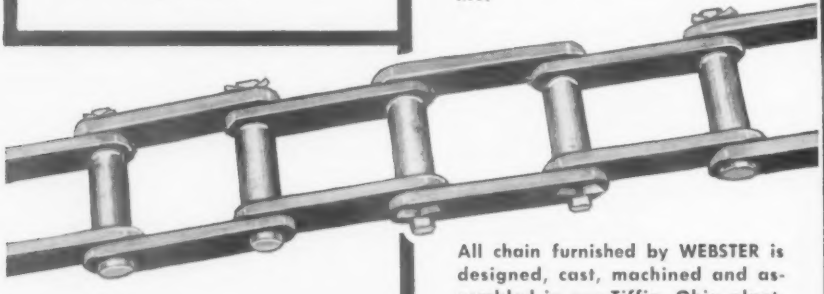


No. 720-S CHAIN

Designed especially for straight-line sludge and grit collectors, where long economical service is important. Pin and cotter construction. Pins have "T" heads securely fitted between lugs cast on side bars. This design prevents the pins from turning in the side bars, thereby distributing the wear over a large area in the barrels of the links. Available in malleable iron or Duramal which is approximately 20% stronger than malleable iron.

No. 111-N CHAIN

Designed for handling abrasive materials such as encountered in grit collectors. The barrels of the links are eliptical in shape to provide more material at point of greatest wear. This feature, together with the close-fitting joints, steel coupler links, and stationary steel pins provide maximum performance, sustained accuracy of pitch, and exceptionally long life.



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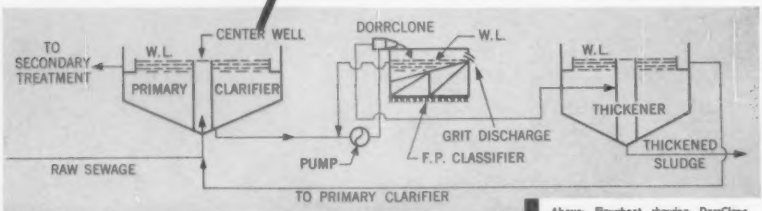
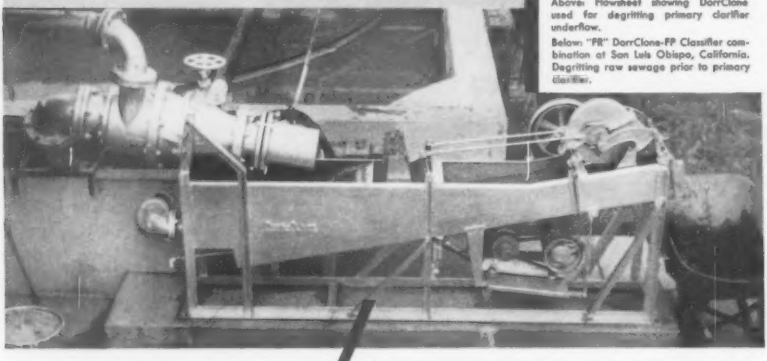


Above: Flowsheet showing DorrClone used for degritting primary clarifier underflow.

Below: "FR" DorrClone-FP Classifier combination at San Luis Obispo, California. Degritting raw sewage prior to primary clarifier.



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Sewage Works

FUNDAMENTAL HYDRAULIC PRINCIPLES OF TRICKLING FILTERS *

By Don E. Bloodgood, G. H. Teletzke, and F. G. Pohland

Respectively, Professor of Sanitary Engineering, Associate Professor of Sanitary Engineering, and Research Assistant, Purdue University, Lafayette, Ind.

In sewage treatment by trickling filters, intimate contact between the sewage and the organisms which inhabit the slime on the trickling filter media is of paramount importance for successful biological oxidation. Consequently, the degree of oxidation obtained is related to the time of contact between the organisms and substrate. Although general observations have been made concerning the factors which affect contact time, little has been accomplished toward experimental and theoretical evaluation of these factors. Therefore, it is the purpose of this paper to present additional information in an attempt to provide a better understanding of the factors affecting time of flow through, or contact time in a trickling filter.

Theory

The theoretical relationships derived by Howland (1) relating the contact time to the rate of discharge of water over an inclined plane and a sphere have been valuable in establishing parameters for evaluating the experimental studies. In both the case of the inclined plane and the sphere, the time of flow, or contact time, is inversely proportional to the two-thirds power of the rate of flow. In the case of the inclined plane, the time of flow is also inversely proportional to the one-third power of the sine of the angle of inclination of the plane to the horizontal, hereafter referred to as the slope. In the case of the sphere, the derivation assumes the sine of the angle of inclination of the surface to be 1.0, consequently, this function does not appear in the equation derived for the sphere. However, the size of the sphere is important since the time of flow over it increases as the five-thirds power of its radius.

Figure 1 provides the basis from which the theoretical relationships between the time and rate of flow of water over an inclined plane and a sphere are developed. The time of flow over the surface (T) is represented by

$$T = \left(\frac{3\nu}{g}\right)^{1/3} \frac{A}{S^{1/3}Q^{2/3}} \quad \ldots\ldots (1)$$

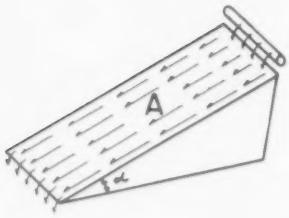
for an inclined plane and by

$$T = 2.6\left(\frac{3\nu}{g}\right)^{1/3} \frac{(2\pi)^{2/3}r^{5/3}}{Q^{2/3}} \quad \ldots (2)$$

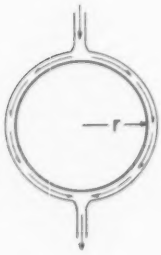
for a sphere, wherein

A = Area of inclined plane surface,
g = Gravitational acceleration,
Q = Rate of flow = volume/time,
r = Radius of sphere,
S = Slope of plane expressed as sine of angle α,
T = Time of flow over surface,
ν = Kinematic viscosity of water.

* Presented at the 31st Annual Meeting, Federation of Sewage and Industrial Wastes Assns.; Detroit, Mich.; Oct. 6–9, 1958.



INCLINED PLANE



SPHERE

FIGURE 1.—Diagrams from which the theoretical relationships between the time and rate of flow of water over an inclined plane and a sphere are obtained.

Experimental Apparatus

The theoretical relationships derived for the flow of water over a sphere and an inclined plane have been evaluated by two types of apparatus. In each case the apparatus conformed as closely as possible to the conditions of theory but was sufficiently flexible to permit adequate investigation of many factors affecting contact time.

Ball Apparatus

The first type of apparatus utilized, by which the factors affecting contact time on a series of spheres were studied, consisted of a single strand of balls suspended from a laboratory balance as shown in Figure 2. The liquid was applied directly to the top of the uppermost ball and flowed by gravity over the surface of each ball in the series.

The rate of liquid application to the balls was varied during different test periods, but was maintained within limits which appeared to provide complete coverage of the balls at low rates and prevent splashing at high rates. The application rate was determined by measuring the entire discharge from the balls over a known time interval. The time of flow of liquid over the balls, or contact time, was calculated by dividing the weight of liquid on the balls at any instant by the liquid application rate. The weight of liquid on the balls was determined by weighing the balls during liquid application and again 15 min after application was interrupted. The free liquid drained from the balls during the 15-min period following cessation of flow. The weight of water flowing during application was computed as being equal to the difference between the weight of the apparatus during liquid application and the weight of the drained apparatus.

Inclined Plane Apparatus

The second type of apparatus used, for investigation of the factors affecting contact time on an inclined plane, consisted of a shallow trough 7 in. wide and 45 in. long as shown in Figure 3. The trough was constructed with a Plexiglas bottom and aluminum angle sides and was hinged at the lower end in order that the slope could be varied. Fine sand was cemented to the surface of the Plexiglas to aid in uniform distribution of flow over the trough. The entire trough was supported on a beam scale to facilitate determination of the trough and liquid weights. The flow was distributed evenly across the upper end of

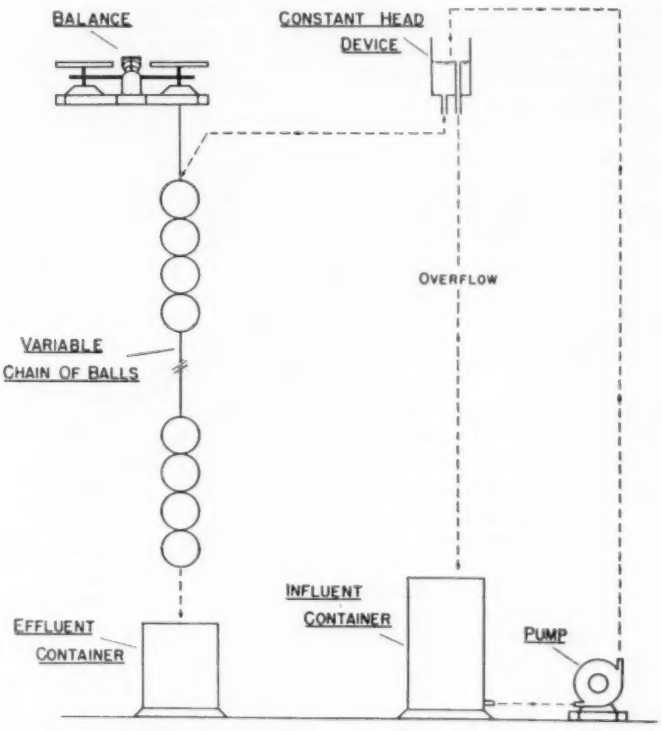


FIGURE 2.—Ball apparatus for measuring water contact time.

the trough by means of a perforated metal tube which extended across the width of the trough.

The contact time, the weight of flowing liquid, and the discharge rate were determined in the same manner indi-

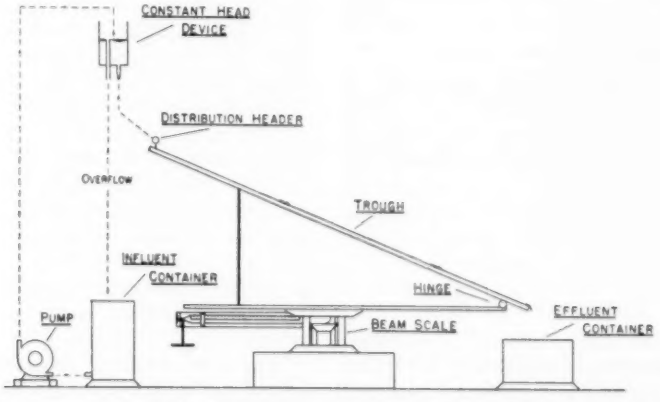


FIGURE 3.—Trough apparatus used to investigate the factors affecting contact time on an inclined plane.

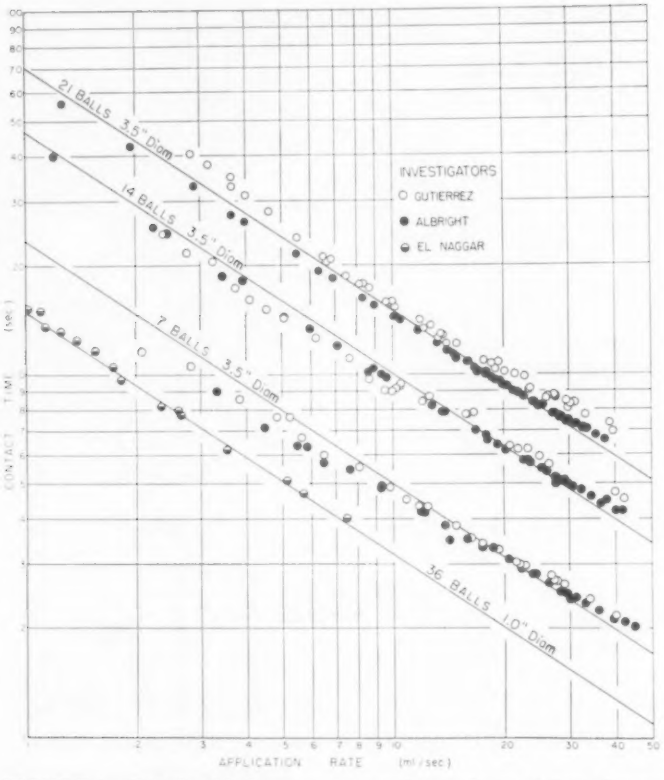


FIGURE 4.—Relationship between contact time and rate of flow of water over the ball apparatus (Figure 2).

cated in the discussion of the ball apparatus.

Experimental Studies

To conform with the conditions of the theoretical equations, experiments were conducted with tap water flowing over the experimental apparatus. To determine the effect of a slime layer on contact time, additional experiments were conducted with sewage flowing over slime-covered apparatus.

Flow of Water over Ball Apparatus

Utilizing the previously described ball apparatus, experiments were conducted in which tap water was discharged over two sizes of balls and several apparatus lengths. The major portion of this phase of the investigation was conducted with 3.5-in. diameter rubber balls suspended on a wire. The number of balls employed was increased from 7 to 14 and finally to 21, giving respective apparatus lengths of 2.04, 4.08, and 6.12 ft. A similar apparatus constructed of 36 one-inch diameter plastic balls suspended on a nylon thread was also used. The water application rate to the 3.5-in. diameter balls was varied from 1.2 to 45 ml/sec, and the rate of application to the 1-in. diameter balls was varied from 0.87 to 7.50 ml/sec.

The data obtained from the tests conducted with the ball apparatus included the application rate and the contact time. The contact time ob-

tained in each run is plotted versus the application rate in Figure 4. Two sets of points determined by independent investigators are shown for the three lengths of the 3.5-in. ball apparatus investigated. A single set of points is shown for the one length of the 1-in. ball apparatus tested. The solid lines drawn through the points represent the theoretical equations for the conditions of the experiments.

Examination of Figure 4 indicates that exceptionally good agreement exists between theory and experimental results. The plotted data for the 1-in. diameter balls almost coincide with theory, whereas the data for the 3.5-in. diameter balls yield a somewhat flatter slope than that derived from theory. Howland (1) pointed out that a flatter slope curve would be caused by channeling of flow at low rates of application and turbulence at high application rates.

In respect to differential in apparatus lengths, the data obtained on the 3.5-in. balls agree more consistently with theory as the length of the chain of balls increases from 7 to 14 to 21 balls. The difference observed between theory and experiment is most noticeable at the higher application rates, particularly on the seven-ball chain. This observation seems to indicate that the method of introducing the liquid to the initial ball had an effect which increased the contact time over that predicted by theory, and that this effect became more influential as the rate of flow increased.

The difference observed between theory and experiment can be explained partially by consideration of some of the assumptions made during theoretical derivation. Howland assumed that the flow is introduced at a single point on the top of the initial ball and that laminar flow conditions exist throughout the system. However, he also showed that turbulent flow may exist on top of the first ball at high rates of flow. Turbulence tends to increase the time of flow. Therefore, turbulence on the initial ball would have a greater effect on contact time on a short chain of balls than on a longer chain.

TABLE I.—Comparison Between Theoretical and Empirical Equations for Time of Flow of Water over a Vertical Chain of Balls

Ball Diameter (in.)	Theoretical Equation*	Empirical Equation*
1.0	$T = \frac{0.415N}{Q^{0.667}}$	$T = \frac{0.418N}{Q^{0.665}}$
3.5	$T = \frac{3.34N}{Q^{0.667}}$	$T = \frac{2.67N}{Q^{0.601}}$

* Nomenclature: T = time of flow or contact time in seconds; N = number of balls in chain; and Q = rate of flow or application in ml/sec.

For comparison, the theoretical equations and the empirical equations obtained from the data for the tests conducted with each ball size and determined by the method of least squares are presented in Table I.

Flow of Water over Inclined Plane Apparatus

Water was discharged over the previously described inclined plane apparatus at rates varying from 1.25 to 21.75 ml/sec. A total of 120 tests were conducted at trough angles varying from 2.87 to 45 degrees. The equation of best fit relating contact time to application rate and slope of the trough as obtained from analysis of all the data by the method of least squares was

$$T = \frac{31.45}{Q^{0.605} S^{0.277}} \quad \ldots\ldots\ldots (3)$$

wherein the units for T, Q, and S are the same as those in Equations 1 and 2.

The contact times obtained at the flattest (2.87-degree) and steepest (45-degree) slopes have been plotted in Figure 5 at the application rates used. These data are compared with

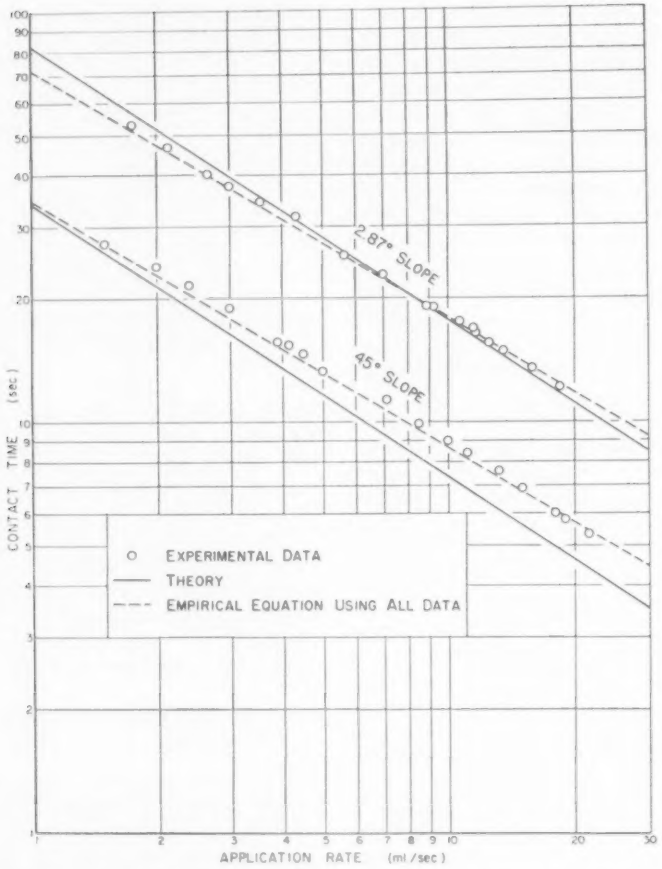


FIGURE 5.—Relationship between contact time and rate of flow of water over the inclined plane apparatus (Figure 3).

the equation of best fit obtained from all of the data and with the theoretical equation.

Analysis of Figure 5 indicates that the experimental data yield a flatter slope when plotted than that derived from theory. This difference may again be attributed, as in the case of the ball apparatus, to channeling at low flow rates and turbulence at high flow rates. The difference is greatest at the steepest slopes which may have been caused in particular by the difficulty encountered in obtaining even distribution of flow at the steeper slopes. Despite efforts to correct this situation, even distribution and "sheet" flow were difficult to obtain, especially at steep slopes.

Influence of Slime on Contact Time

To determine the effect of slime on contact time, 96 test runs were conducted on the trough apparatus with sewage flowing over an initially developed slime layer. The slope of the trough was varied from 2.28 to 49.0 degrees and the rate of application was varied from 0.28 to 25.0 ml/sec. The weight of slime on the trough was

determined by subtracting the weight of the trough without slime from the weight of the slime-covered trough obtained after the trough was allowed to drain for 15 min. The 15-min drainage period was found to be sufficient to allow the free water to drain from the slime. Therefore, the weight determined 15 min after cessation of sewage flow included the wet slime weight. The weight of water flowing over the trough during a test period was determined as indicated previously in the other studies.

The data obtained from these tests were analyzed by the method of least squares and yielded the following equation of best fit:

$$T = \frac{39.0}{Q^{0.652}S^{0.349}} \quad \ldots\ldots\ldots (4)$$

If Equation 4 is compared with Equation 3 obtained for contact time without slime and with the theoretical development (Equation 1), it is readily seen that the exponents of Q and S in Equation 4 are in better agreement with the exponents in the theoretical equation than are the exponents obtained in Equation 3. This was believed to be a result of more even distribution of flow over the surface when slime was present than when slime was absent.

The equations for the theoretical (Eq. 1), with slime (Eq. 4), and without slime conditions (Eq. 3) and the computed contact times for slopes of 2.87 and 45 degrees and application rates of 1 and 20 ml/sec are compared in Table II. The comparison indicates that slime increased the contact time over theoretical flow conditions by 30 to 41 per cent, whereas the increase over that obtained on an apparatus without slime varied from 9 to 54 per cent. Evidently the effect of slime on increasing contact time is a function of the slope and rate of application. The data in Table II also indicate that the greatest increase in contact time attributable to the slime (54 per cent) was obtained at low application rates (1 ml/sec) and flat slopes (2.87 degrees), whereas the smallest increase (9 per cent) was obtained at high application rates (20 ml/sec) and steep slopes (45 degrees). Therefore, it was believed that the increase in contact time attributed to the slime layer on the trough was decreased by increasing the rate of application or by increasing the slope of the trough. Consequently, if the slope of the trough or the application rate were increased sufficiently it is possible that the increase in contact time due to slime would become negligible.

TABLE II.—Comparison of Equations for Time of Flow Over the Inclined Plane Apparatus

Rate of Application, Q (ml/sec)	Slope of Plane, S (degrees)	Contact Time (sec)			Increase in Contact Time Due to a Slime Layer (per cent)	
		Theoretical*	Without Slime†	With Slime‡	Over Theory	Over Water
1.0	2.87	82.1	72.0	111.0	35	54
20.0	2.87	11.1	11.7	15.7	41	34
1.0	45	33.9	34.7	44.0	30	27
20.0	45	4.6	5.7	6.2	35	9

* Contact time, Theoretical $= \frac{30.2}{Q^{0.667}S^{0.333}}$.

† Contact time, Without Slime $= \frac{31.45}{Q^{0.605}S^{0.277}}$.

‡ Contact time, With Slime $= \frac{39.0}{Q^{0.652}S^{0.349}}$.

The foregoing hypothesis was supported by the initial considerations in the development of the theoretical relationship for flow over spheres. Howland's (1) derivation assumes that the flow over a sphere is similar to the flow over a vertical plane surface. Since the contact time increase effected by the slime is apparently diminished as the slope of the surface increases, it could be expected that the slime on a sphere would have little effect in increasing contact time.

This assumption was substantiated by experiments in which the contact time was obtained for sewage flowing over slime-covered ball apparatus. The one-inch diameter ball apparatus was used and the experimental results obtained with sewage and slime on the balls were compared to the results obtained without slime on the balls. The experimental results indicated that the slime layer caused more variability in the data, a condition also noted during the trough experiments,

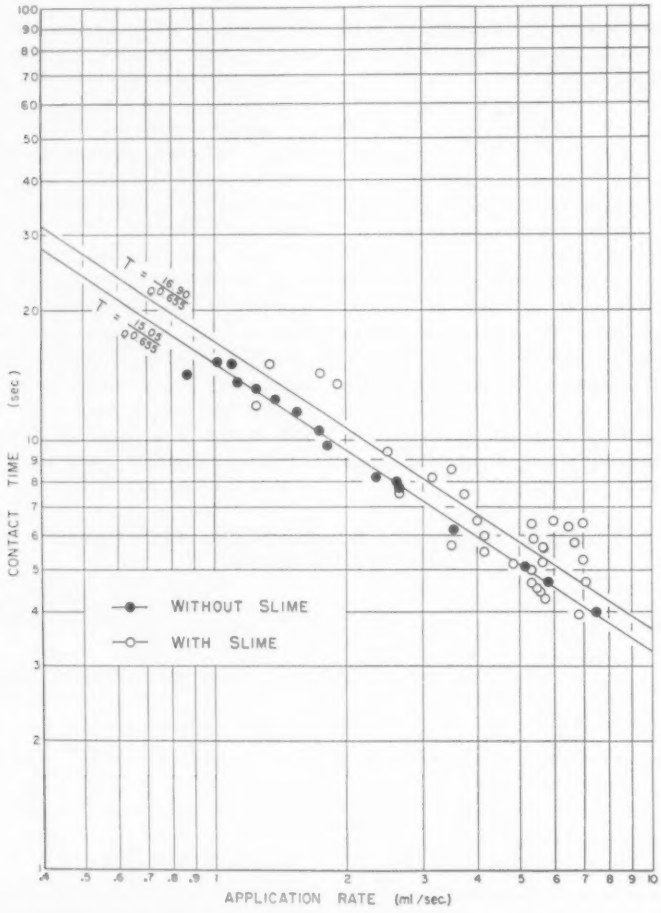


FIGURE 6.—Comparison between contact time with and without slime on the one-inch ball apparatus (Figure 2).

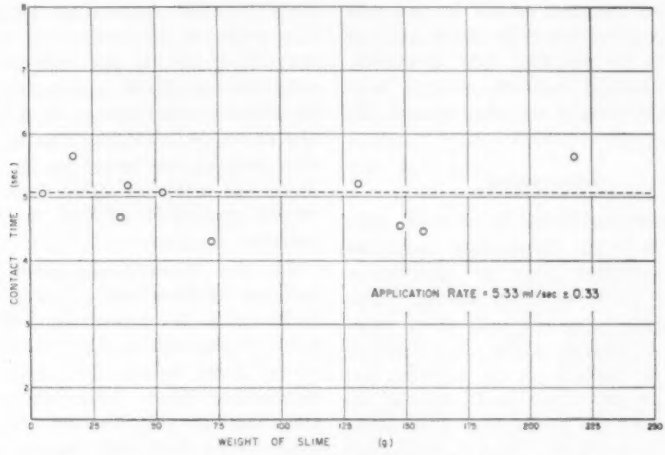


FIGURE 7.—Effect of slime weight on contact time for the one-inch ball apparatus at a nearly constant application rate.

but the contact times obtained were not much greater than those obtained without slime. The experimental data for conditions with slime and those without slime are shown in Figure 6 with their respective equations of best fit.

The contact times obtained with slime were computed to be on the average 12 per cent higher than those obtained without slime. This small increase in contact time over that obtained with water alone may be attributed to the slight increase in ball size caused by the slime layer. To support this assumption, it can be calculated that an increase in ball diameter of 0.07 in. would alone account for a 12 per cent increase in contact time. In other words, the mere presence of a 0.035-in. layer of slime on the 1-in. balls would account for the 12 per cent increase in contact time mentioned previously. In most cases, the slime layer on the balls was observed to be in excess of 0.035 in. However, it should be noted that as the ball size is increased the slime layer on the ball becomes less influential in increasing contact time. For example, if a 3.5-in. diameter ball has a slime coating of 0.035 in. the increase in contact time computed from the theoretical equation is only about 3 per cent. Actually, in a limited number of tests conducted with 3.5-in. diameter balls, the difference in contact time obtained with and without slime was insignificant.

Effect of Slime Weight on Contact Time

The effect of slime weight on contact time was investigated by comparing the contact times obtained on the one-inch diameter ball apparatus at approximately constant application rates and at different slime weights. The comparison indicated that the weight of slime had no significant effect on the contact time. The contact times obtained at the various slime weights are shown in Figure 7.

Similar results were found by analysis of the data obtained in the 96 tests conducted on the slime-covered trough apparatus. In these tests the slime weight varied from 85 to 456 g, and analysis of the data by the method of least squares revealed that the contact time was inversely proportional to the 0.01 power of the weight of the slime.

Since any number raised to the 0.01 power is approximately unity, it can rationally be assumed that there was no relationship between contact time and slime weight on the trough apparatus.

Discussion

Experimental data have been presented to verify theoretical equations relating contact time to application rates on trickling filter media. The experiments have not only been valuable in providing a basis for further laboratory studies on the relation between contact times and organic removals, but the principles and equations which have been established should also be applicable to full-scale trickling filter installations.

The application rates used in the studies with the ball apparatus may be expressed in terms more familiar to those working with trickling filters; that is, million gallons per acre per day, or gallons per day per square foot. To accomplish this, the flow applied to the balls can be considered to be applied on an area equal to the cross-sectional area of a ball. The application rates computed in this manner varied from 18 to 670 mgd/acre or 414 to 15,410 gpd/sq ft on the 3.5-in. diameter balls, and were as high as 1,400 mgd/acre or 32,200 gpd/sq ft on the 1-in. diameter balls. These application rates may seem high when compared to conventional application rates used in full-scale treatment plants, but it must be remembered that even a high-rate trickling filter is actually dosed intermittently as the rotary distributor arms pass over the filter surface, and the instantaneous hydraulic loading is much higher than the average. For example, it has been observed that a circular high-rate trickling filter with four distributor arms receiving an average hydraulic loading of 20 mgd/acre or 460 gpd/sq ft is actually being dosed on only about one per cent of its surface at any instant. The actual instantaneous hydraulic loading on any point of the surface of this filter may then be on the order of 2,000 mgd/acre or 46,000 gpd/sq ft. If the distributor arm rotates at a speed of one rpm, the actual hydraulic application rate at any point on the surface is on the order of 2,000 mgd/acre or 46,000 gpd/sq ft applied at 15-sec intervals.

If the theoretical equations developed by Howland (1) are assumed to be valid, the contact time of sewage flowing through a filter is inversely proportional to the 2/3 power of the application rate. This indicates that doubling the application rate on a given filter bed will reduce the contact time by 37 per cent. Therefore, to obtain the same contact time with the media at the doubled application rate it would be necessary to provide 59 per cent more filter depth, or double the filter surface area. Obviously, under usual conditions it would be more economical to provide 59 per cent more filter depth.

Consideration of the effect of media size on contact time strongly indicates that a small-sized media should be preferred. If it is assumed that the media in a trickling filter is spherical in shape and that the contact time increases as the 5/3 power of the media radius, then doubling the media diameter will increase the contact time on one sphere by 318 per cent. However, a given volume of a bed of spheres will contain only one-eighth as many spheres if the sphere diameter is doubled. Therefore, the over-all effect of increasing media size to twice its previous diameter is to decrease the contact time in a given media volume by 40 per cent.

The studies have also shown that the amount of slime on a spherical filter media has very little effect on contact time, especially at high application rates. Therefore, in respect to contact time, there would be little advantage in attempting to maintain

large amounts of slime on the filter media.

The implications of the reported results are that a deep filter containing the smallest practical media is to be preferred to obtain a given contact time at maximum efficiency.

Conclusions

1. Experimental results have verified theoretical equations in which liquid contact time on an inclined plane and on a sphere is inversely proportional to the 2/3 power of the liquid application rate.

2. Experimental results have supported theory whereby contact time on a sphere is directly proportional to the 5/3 power of the radius of the sphere.

3. Experimental results have supported theory whereby the contact time of sewage flowing over an inclined plane is inversely proportional to the 1/3 power of the sine of the angle of inclination between the plane and the horizontal.

4. The effect of slime growth on contact time on an inclined plane is related to the slope of the plane and the application rate. When the slope of the plane is flat (2.87 degrees) and the application rate low, slime may increase contact time in excess of 50 per cent. When the slope of the plane is steep (45 degrees) and application rates high, the contact time may be increased less than 10 per cent by the slime.

5. The weight of slime on a trickling filter has no relationship to the contact time obtained between sewage and media.

Acknowledgments

The experimental work reported herein was conducted by Richard O. Albright, Leonardo V. Gutierrez, Joseph E. Rempe, and Ahmed Sami El-Naggar, while graduate research assistants at Purdue University. The investigations were supported in part by National Institutes of Health grant G-3845, the Engineering Experiment Station of Purdue University, and the following companies: Ayer McCarel Clay Company, Inc., Brazil, Ind.; Bowerston Shale Company, Bowerston, Ohio; Cannelton Sewer Pipe Company, Cannelton, Ind.; W. S. Dickey Clay Manufacturing Company, Kansas City, Mo.; Natco Corporation, Pittsburgh, Pa.; Pomona Terra Cotta Company, Pomona, N. C.; and Texas Vitrified Pipe Company, Mineral Wells, Tex.

Reference

1. Howland, W. E., "Flow Over Porous Media as in a Trickling Filter." *Proc. 12th Ind. Waste Conf.*, Purdue Univ., **94**, 435 (1958).

OLD PHOTOGRAPHS NEEDED

A Hollywood producer, commissioned to make a film featuring the public works services, needs assistance in locating material.

The film will show improvements in the services the citizen gets today. To do this, each service will be introduced by an "in the old days" bit. This will be done with old photographs, of the period 1890 through 1910, showing the conditions of the times (and the need for improvement) in sewers and sewage disposal, and other public works.

The producer needs a selection of the best possible old photographs relating to sewers and sewage disposal. Any loaned photographs will be duplicated promptly and returned within a few days. Photographs should be sent to Mr. Sam Farnsworth, Parthenon Pictures, 2625 Temple Street, Los Angeles 26, California.

EFFECTS OF MAGNETIC STIRRING ON THE DROPPING-MERCURY ELECTRODE

By Chris Potos

Chemist, Milwaukee Sewerage Commission, Milwaukee, Wis.

The polarogram used in the determination of the oxygen utilization of an activated sewage sludge is a curve obtained by plotting galvanometer deflections against time. The slope of this curve, which is in fact a straight line, is a measure of the oxygen utilization rate of the sample. Invariably, on plotting the polarographic data for a given period of time, a line with a two-stage characteristic is obtained. The first stage, which has a duration of 2 to 3 min, has the greater slope. The second stage endures for the remainder of the period and has the lesser slope (Figure 1). The explanation of this two-stage characteristic is as follows: For that part of the curve which has the greater slope, in other words the first 2 or 3 min, a progressively decreasing amount of sludge is in suspension and most of it is subjected to the dissolved oxygen of the effluent. Once the sludge is settled, only the fine surface layer of that sludge is exposed to the remaining dis-

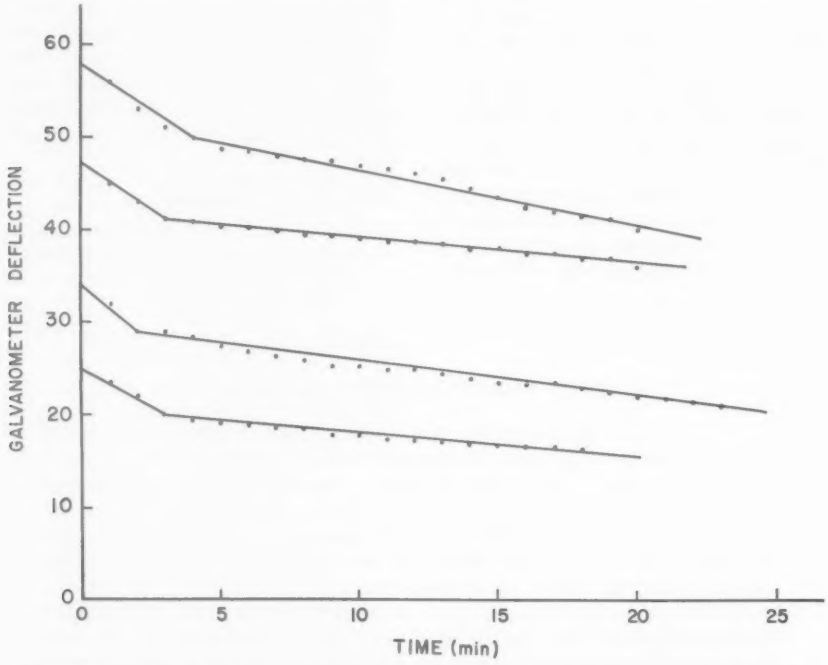


FIGURE 1.—Typical polarograms showing two-stage characteristics of an undisturbed activated sludge sample.

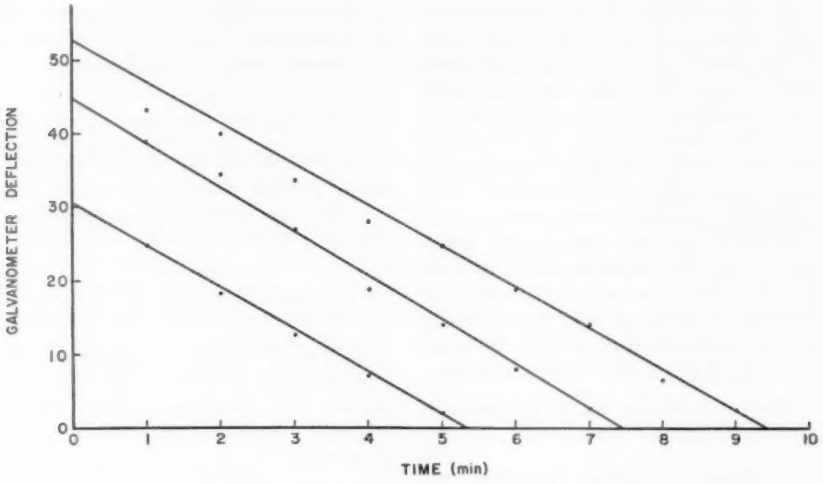


FIGURE 2.—Typical polarograms from studies of stirred activated sludge samples.

solved oxygen in the effluent. Hence a decided drop in oxygen utilization takes place which accounts for the lesser slope of the second and longer line. This means that a true DO-uptake rate of a sample is measured only when the solids are in complete suspension.

At Milwaukee it has been found that better results are obtained by taking galvanometer deflection readings every minute instead of after every half minute. Allowing 2 min for sludge settling, the two readings that can be taken inside that time are not entirely sufficient to plot an oxygen utilization curve. It was felt that some type of stirring mechanism should be used in conjunction with the polarograph.

The Stirrer

Specifications

With the above observations in mind, a search for a satisfactory stirring mechanism was initiated. Such a stirring mechanism must satisfy certain requirements:

1. It must agitate the floc mildly so as not to break up the sludge particles. The break-up of sludge particles results in greater surface areas being exposed to the dissolved oxygen of the effluent which results in higher oxygen-utilization readings.

2. Agitation must occur without introduction of air into the system.

Because of the small size of the cell, the introduction of a stirring rod from above proved unsatisfactory. Stirring by shaking the cell itself proved unfeasible because of the stationary nature of the apparatus. A magnetic stirrer was then employed with fairly good results. Some drawbacks were noticed which will be mentioned below.

Interferences

The magnetic stirrer met all the aforementioned requirements and the deflection readings were taken every minute (Figure 2). In general, the curves obtained were good, although quite frequently readings were taken which were out of line. These readings were rejected and those which fell in line were accepted. This is the drawback mentioned above. The rejected readings were probably caused by one or a combination of two or three of the following conditions:

1. The collision of the forming mercury drop with swirling sludge particles interfered with the formation and consequent size and electrical characteristics of the mercury drop.

2. The turbulence of the liquid itself interfered with the formation and consequent size and electrical characteristics of the mercury drop.

3. There is also the strong possibility that the magnetic field induced by the stirrer may affect the electrical field set up between the two electrodes of the polarographic system thus accounting for the abnormal readings.

Each one of the above possibilities will be considered separately.

Effect of Sludge Particles

Procedure and Results

To investigate the effect of swirling sludge particles (Condition 1), a procedure was adopted which permitted the determination of drop-time at various stirrer speeds.

The normal drop-time for the polarograph in an undisturbed one per cent potassium chloride solution is one drop every 3 or 4 sec. The drop-time had to be checked in a disturbed flocculent mixture. Mixed liquor could not be used because its dark color made it impossible to see the electrode and mercury drop. The problem was to form a clear or light colored, flocculent mixture so that the electrode system could be seen while in operation. After several unsuccessful attempts to duplicate mixed-liquor floes (including small pieces of paper), it was determined that aluminum hydroxide floes would be satisfactory. The drop-time was checked in the presence of these floes at variable stirrer speeds. The stirrer speeds used were: (a) a speed just sufficient to keep the floe in suspension, (b) a speed greater than necessary to keep the floe in suspension, and (c) the highest speed available.

In Test A the stirrer was run at a speed just sufficient to keep the floe in suspension. Drop-times during a one minute run were as follows:

sec/drop								
3.5	3.5	3.5	3.5	3.0	3.5	3.5	3.0	3.5

In Test B the stirrer was run at a speed greater than necessary to keep the floe in suspension. Drop-times during a 30-sec run were as follows:

sec/drop									
1.0	1.0	2.0	1.0	2.0	3.0	2.0	1.0	1.0	1.0
1.0	2.0	1.0	1.0	3.0	2.0	1.0	1.0	2.0	1.0

In Test C the stirrer was run at the highest speed available. No drop formation was observed, rather a very fine spray was emitted from the electrode tip.

Interpretation of Results

It was determined that swirling aluminum hydroxide floes alone or in conjunction with one of the other conditions inhibited the formation and consequent size of the mercury drop only when the magnetic stirrer is used at the higher speeds. The faster the speed the more erratic are the results. At speeds just necessary to keep the floe in suspension, the results indicate that the mercury drop is not materially affected by swirling floe.

Effect of Turbulence

Procedure and Results

To investigate the effect of turbulence (Condition 2), a procedure similar to that used for determining the effect of particle collision was adopted.

From the previous experiments it was noted that as the stirrer speed increased the effect on drop-time became more pronounced. For that reason it was believed that possibly the turbulence of the liquid itself causes the greater difficulty. Therefore, the drop-time was checked in an agitated liquid containing no floe or suspended matter. The drop-time was observed for the three speeds used previously.

Here again the results were dictated

by the speed at which the liquid in the cell was mixed. At a slow speed, one just sufficient to keep the floc in suspension, there was no material effect on the mercury drop. Results of a one-minute drop-time test were as follows:

sec/drop

3.0 3.5 3.5 3.5 3.5 3.0 3.0 3.5 3.5

As soon as the speed of the stirrer was increased, which consequently increased the turbulence, the formation of the drop was materially affected. In fact, at great speeds no drop formation was noticed at all, rather a fine spray was again emitted.

Interpretation of Results

It was determined that turbulence as well as floc collision, or possibly a combination of the two, plays a part in the abnormal readings encountered when a magnetic stirrer is used.

Effect of Magnetic Field

Procedure and Results

To determine if there is interference between the magnetic field produced by the stirrer and the electrical field set up between the two electrodes (Condition 3), the magnetic stirrer was first turned up to a point slightly less than that required for activation of the stirring rod. The drop-time was noted for one minute with the following results:

sec/drop

3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5

These results indicate that there is no appreciable effect exerted by the magnetic field on the electrical field at the point just before activation of the stirring rod. The results from this test, however, were thought to be somewhat inconclusive and questionable so another test was devised. In this new test the stirring rod was made stationary by placing over it a grooved, heavy rubber block. The magnetic stirrer was turned up to that point (predetermined) just necessary to keep the floc in suspension. The drop-time was then noted for one minute with the following results:

sec/drop

3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5 3.5

These results corroborate conclusively the results obtained in the first magnetic-field experiment.

Still another test was made, keeping the stirring rod stationary, but increasing the current applied to the magnetic stirrer to full capacity. The drop-time was then noted for one minute with the following results:

sec/drop

2.5 2.5 2.0 2.5 2.5 3.0 2.5 2.5
2.0 2.5 2.5 2.5 2.5 2.5 3.0 2.5

Interpretation of Results

With the stirrer turned up to its highest capacity, there is a definite effect on the drop-time. The results, however, are very uniform and are unlike those obtained when free movement of the stirring rod is allowed. The drop-time is increased to one every 2.5 sec instead of the normal value of one drop every 3.5 sec. The results indicate clearly that a strong magnetic field does affect the drop-time while a weak magnetic field, such as that just necessary to keep solids in suspension, has relatively little effect.

Conclusions

As was stated before, the magnetic stirrer is not perfect, but it is the best tested so far. In order to eliminate or minimize the error introduced by: (a) the turbulence of the liquid, (b) the collision of the swirling sludge particles with the drop forming at the electrode tip, (c) the magnetic field produced by the stirring apparatus, or (d) a combination of two or three of these conditions, it is necessary to maintain the stirrer at the lowest

speed required to keep the solids in suspension.

It should be reported that the diffusion current is increased by stirring the sludge in the cell. However, this is of little importance when making oxygen-utilization observations, for if the stirrer speed is uniform, the increase in diffusion current remains uniform.

Acknowledgment

The author wishes to express his sincere thanks to Henry M. Heisig, Director of Laboratory; Lester Schier, Assistant Director of Laboratory, Milwaukee Sewerage Commission; and Prof. Raymond Bournique, Marquette University, for their suggestions and help.

PHS EXAMINATIONS

The Public Health Service has announced that competitive examinations for appointment to the Commissioned Corps of the Service will be held throughout the Nation in March and April of 1959.

The professional and scientific categories covered include examinations for sanitary engineers and biochemists. These examinations will be given April 21, 22, 23, and 24 at the Public Health Service installation nearest the applicant's home, school, or place of business.

To be eligible for appointment to the Regular Corps, candidates must be United States citizens, graduates of approved schools, and at least 21 years of age. Biochemists must have earned a Doctorate.

Appointments will be made in the ranks of Assistant and Senior Assistant, equivalent to Navy ranks of Lieutenant (j.g.) and Lieutenant, respectively.

Application forms and further information may be obtained by writing to the Surgeon General, U. S. Public Health Service (P), Washington 25, D. C.

RESEARCH ASSISTANTSHIPS

The State College of Washington has available research assistantships in sanitary engineering for the academic year 1959–60. Work toward the Master of Science in Sanitary Engineering degree can be completed in three or more semesters. Applicants should have an engineering degree and essential prerequisites for their specific graduate program, or be willing to make up deficiencies.

For further information, write E. B. Moore, Chairman, Department of Civil Engineering, State College of Washington, Pullman, Washington.

COMPARISONS OF SHORT-TERM WITH 5-DAY BOD DETERMINATIONS OF RAW SEWAGE*

By H. E. Orford and F. E. Matusky

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Investigators at the turn of the century under the auspices of the 1898 British Royal Commission on Sewage Disposal determined that a significant relationship existed between the dissolved oxygen values of river water and the degree of pollution of these waters. As a result of this work, in 1913 the British Commission recommended that the amount of "dissolved oxygen adsorbed in 5 days at 65°F" should be used as a standard procedure for the measure of pollution. During the past 46 years this measure of oxygen requirement of polluted waters has been further developed and standardized and is now known simply as the biochemical oxygen demand test.

The standard procedure for BOD tests was adopted in 1936 by the "Standard Methods" committee, and requires a 5-day incubation period at 20°C. This relatively long incubation period is a disadvantage, particularly when the BOD test is used for treatment control purposes.

The original work by the investigators of the British Royal Commission included studies of 24-hr and 48-hr tests. The commission decided that the 5-day test would minimize errors in technique by allowing a greater percentage of the waste to oxidize.

The purpose of this study is to investigate, using present BOD techniques: (a) the accuracy and reproducibility of the BOD test for domestic sewage using incubation periods less than 5 days, (b) the relationship between short period BOD values and those obtained by the standard 5-day test, and (c) the possibility of predicting the standard 5-day BOD value from the results of a shorter time BOD test. Little information is found in the literature concerning these purposes.

Many studies have been made to determine the oxidation rate constant, or k_1 value, for domestic sewage. Theriault (1) early established that the k_1 value at 20°C was approximately 0.1, as used in the traditional oxygen demand equation

$$y_t = L(1 - 10^{-kt}) \quad \ldots\ldots (1)$$

where

y_t = BOD at any time t,
t = time in days,
L = total or ultimate BOD, and
k_1 = oxidation constant.

Most modern investigators have shown that the k_1 value for domestic sewage, using BOD curves up to 5 and 7 days is much higher than 0.10. A commonly accepted average for k_1 is 0.18 which was reported by the Com-

TABLE I.—BOD Values for One to Five Days Calculated Using Various Oxidation Rate Constants

Time (Days)	BOD as Per Cent of 5-Day BOD		
	$k_1 = 0.10$	$k_1 = 0.18$	$a = 1.0$
1	30	41	41
2	54	64	67
3	73	81	81
4	88	93	92
5	100	100	100

* Paper of the Journal Series, New Jersey Agricultural Experiment Station, Rutgers University, Department of Sanitation, New Brunswick, N. J.; presented at the 43rd Annual Meeting of the New Jersey Sewage and Industrial Wastes Assn.; Atlantic City, N. J.; Mar. 12–14, 1958.

mittee on Sanitary Engineering of the National Research Council (2). Computed BOD's for k_1 values of 0.10 and 0.18 are given in Table I and expressed as per cent of the 5-day BOD.

Orford and Ingram (3) developed the following logarithmic equation for the BOD curve:

$$y_t = S(0.85 \log at - 0.41) \ldots (2)$$

where

y_t = BOD at any time t,
a = BOD rate constant,
t = time in days,
S = a constant = BOD at $\frac{5}{a}$ days, and
0.85 and 0.41 = constants.

In these studies the rate constant for domestic sewage was set at unity. In Table I the values computed from the logarithmic equation are based on a rate constant of $a = 1.0$.

To evaluate the reproducibility of any short-time BOD test, it is first necessary to establish the reproducibility of the standard 5-day BOD test. The reproducibility of the BOD test was investigated by the National Research Council (2), using data from sewage treatment plant laboratories at military installations. A testing program was set up in which 2 samples from each of 11 cooperating military camps were tested using 9 bottles of a single dilution for each sample. From these studies it was found that the coefficient of variation, V, for all 5-day, 20°C BOD tests was 7.45 per cent.* Similar tests were run at Washington, D. C., and the Sanitary District of Chicago. At Washington, where three different samples, using nine bottles of a single dilution were run, V was 4.0 per cent. At the Sanitary District of Chicago, where 10 different samples, using 9 replicates of a single dilution, were tested, the coefficient of variation V was 6.4 per cent. When the same 10 samples, using 9 different dilutions were tested, a V of 6.6 per cent was obtained.

* The coefficient of variation $= \frac{\text{standard deviation}}{\text{mean}} \times 100$, which is the per cent standard deviation. The coefficient of variation gives the percentage range above and below the mean value within which two-thirds of the observed values can be expected to fall. Thus, the coefficient of variation becomes one measure of the relative reproducibility of the BOD test.

Literature Review

A review of some of the short-time BOD comparative studies reported in the literature is contained herein.

In 1951, Williams (4) reported on a study of 3-day and 5-day BOD tests of the settled sewage from the Minneapolis-St. Paul sewage treatment plant. The purpose of these tests was to determine the k_1 values of the sewage oxidation curves using these 3-and 5-day BOD values. Analysis of the data from the 54 samples reported shows that the 3-day BOD value averaged 82.1 per cent of the 5-day BOD value. The coefficient of variation of this ratio was determined to be 5.6 per cent.

A 2-day BOD test using a special bacterial inoculum was reported by Zehnpfennig and Nichols (5). In their procedures the inoculum was prepared by filtering settled sewage through a glass filter to remove the protozoa. This was followed by the addition of 1 ml of the protozoa-free sewage to 100 ml of sterile settled sewage prior to incubation at 20°C for 24 hr. The sewage sample for BOD analysis was first sterilized by autoclaving. The sewage was added to BOD bottles in the proper amounts, then 1 ml of the special sewage seed inoculum was added to each bottle and the bottle filled with dilution water. Dilution water control blanks containing 1 ml of inoculum were also included. A standard 5-day BOD test on the sterile sewage was made in order to compare the results of the special 2-day BOD test. Using the same sample of sterile sewage, comparative tests were made on 13 different days, using a different sewage inoculum on each

day. The results for the standard 5-day test showed a V of 24 per cent for the group of 13 average BOD values, while the modified 2-day 20°C test showed a V of only 6 per cent. Comparing results for the individual tests for any one day, the standard 5-day test had a V of 4.6 per cent while the 2-day test had a V of 2.9 per cent.

When the special 2-day BOD was similarly tested on pulp mill waste, the coefficient of variation for the group of 10 standard method BOD values was 12.5 per cent and for the special 2-day BOD, 11.4 per cent. Again comparing results for any one day, the standard 5-day test had a V of 2.3 per cent and the 2-day test a V of 2.2 per cent.

The authors concluded that the modified 2-day test gave more reproducible results because the special sewage seed without protozoa was more uniform in character and free from the influence of protozoa on the bacteria. This conclusion may be questioned since the standard BOD tests which were used for comparison were made on sterile sewage using a small inoculum. It does not necessarily follow that the same tests made on nonsterile sewage would show such great variation in results. Also, the results with the pulp mill waste showed no significant improvement in their reproducibility.

Tidwell and Sorrels (6), using the special inoculum technique of Zehnpfennig and Nichols, evaluated the 2-day BOD test using domestic sewage and pure chemical compounds. With 10 domestic sewages, BOD tests were made in triplicate using: (a) the special 2-day BOD, (b) the standard 2-day test, and (c) the standard 5-day test. The coefficients of variation found were: 2.8, 5.4, and 7.1 per cent, respectively, for the special 2-day, standard 2-day, and standard 5-day tests. The average ratio of the standard 2-day to 5-day BOD was 69 per cent and the coefficient of variation V for the ratio was 17 per cent.

The results show that the reproducibility was better for the special 2-day BOD test than for the 2-day and 5-day standard BOD tests. However, the coefficient for the 5-day test is high considering that each test was run in triplicate. Also, the coefficient of variation for the ratio of the 2-day to 5-day standard BOD is very high although the average ratio of 69 per cent is commonly found.

In another paper by Tidwell and Sorrels (7), the authors evaluated the special 2-day test and the standard 5-day BOD test using asparagine, glutamic acid, and glucose as substrates. In a series of 21 BOD dilution tests using 1,000 ppm asparagine as substrate, the special 2-day BOD test gave a V of 6 per cent while the standard 5-day BOD test gave a V of 9.5 per cent. Again, the special inoculum 2-day test showed greater reproducibility than the standard 5-day test.

The authors calculated the theoretical ultimate oxygen demand of the three substrates from the equations for chemical oxidation. Using the theoretical oxygen demand value as the ultimate BOD value, L, and assuming an oxidation rate constant, k_1, of 0.1, the theoretical 2-day and 5-day BOD values were computed. When comparing the observed 2-day and 5-day BOD values with the computed theoretical values, it was found that the results of the 2-day special inoculum test were within 2 per cent of the theoretical value, while the 5-day standard BOD test values were 20 to 25 per cent less than the theoretical value. It was concluded that the 2-day special test was superior because it gave BOD values near the theoretical value, while the standard BOD test values were well below.

The authors' conclusions are open to question. The ultimate determined biological oxygen demand for organic compounds of this type is more likely to be about 75 per cent rather than 100 per cent of the theoretical oxygen demand based on complete oxidation. This was shown by Gaffney and Heuke-

lekian (8) to be true for acetic acid, butyric acid, and propionic acid. Also, in a standard BOD test, the rate constant for biological oxidation of these soluble compounds is greater than the classical rate constant of 0.1 for sewage oxidation. In most instances the biological oxidation is complete within two or three days and k_1 values of 0.4 to 0.6 are not uncommon.

Dillingham, Knuth, and Wessman (9) have recently reported on a short-term BOD method for sulfite waste liquor, other paper and pulp mill wastes, and river water using the Warburg manometric technique. The following procedure, producing good results with minimum incubation time, resulted from this work.

Wastes were diluted with a nutrient salt solution and incubated on the Warburg apparatus for 18 hr at 37°C. Before incubation each flask was heavily inoculated with solution containing a pure culture of *Aerobacter aerogenes*, which had been washed and then standardized by turbidimetric methods. When the same sample of spent sulfite waste liquor was tested 12 times over a period of 3 months, the BOD results gave a V of 10.2 per cent as compared with a V of 15.7 per cent using the Standard Methods 5-day BOD test.

The relationship between the proposed 18-hr method and the standard 5-day BOD was studied by these authors. Since this relationship unfortunately shows a wide variation with type of paper waste tested, the relationship must be established for each waste to be tested. This variation would be expected for any short-time BOD method, particularly where pure cultures of organisms are used for bacterial seed. Table II gives the relationship found between the 18-hr and 5-day BOD results.

It is interesting that all 18-hr manometric BOD results are less than the 5-day BOD results except with river water, where the manometric BOD results are over 6 times those of the standard 5-day test. The 5-day BOD values on 30 different samples averaged 3.5 mg/l and ranged from 1.9 to 5.5 mg/l, while the 18-hr manometric BOD results on the same samples ranged from 8 to 108 mg/l.

TABLE II.—The Relative Efficiency of BOD Estimation *

Waste	Manometric BOD† Per Cent of 5-Day BOD
River water	643
Kraft white water	26
Kraft pulp mill waste	36
Deinking waste	67
Spent sulfite liquor	86
Spent semichemical liquor	46

* Taken from Dillingham, Knuth, and Wessman (Reference 9).
† 18 hr.

Dillingham, Knuth, and Wessman (9) attach significance to their results showing that the manometric BOD is much greater than the 5-day BOD by stating: "The divergent relationship for river water is probably the result of inefficient oxidation of river water components by the relatively dilute and attenuated inoculum used in the 5-day BOD method."

The peculiar observations of these workers might also be explained by the fact that the special inoculum used had a BOD of 300 to 600 mg/l, while the river water substrate used had a BOD of only 1.9 to 5.5 mg/l. Thus the differences in BOD contributed by the river waters would not be measurable, and the results obtained could only measure the differences in BOD between two samples of inoculum.

Methods of Study

BOD tests were made on fresh domestic sewage with a minimum of change from the procedures prescribed in "Standard Methods." On each sample of sewage obtained, BOD tests were performed for 1, 2, 3, and 5 days incubation at 20°C and for 1 and 2 days incubation at 37°C.

Standard dilution water was prepared from distilled water which had been stored at 20°C for at least 2 days prior to use. The distilled water was aerated and the mineral salts were added about one hour before use. Dilutions of 20:1, 30:1, and 60:1 were set up for each test.

The initial tests at 37°C in a standard bacteriological incubator showed some possible difficulties because: (a) the temperature variation in the incubator was ± 1°C, (b) the temperature of the dilution water was less than 37°C, and (c) the water seals on the BOD bottles could not be maintained and as a result water evaporated from the bottle leaving a small bubble at the top. All of these possible difficulties were investigated by: (a) running a series of tests in a water bath incubator at 37°C where the temperature variation was ± 0.1°C, (b) slowly heating the dilution water to 37°C before use, and (c) providing plastic hoods over the lips of the BOD bottles to prevent evaporation of the water seal. For comparison the same samples were run using a standard bacteriological incubator and without the above precautions. Since the BOD results obtained by the two series were found to be statistically identical, the use of special refinements was abandoned.

To facilitate comparison of BOD values of sewages of different strengths, the original BOD data were expressed as a percentage of the 5-day 20°C BOD. To simplify the statistical computations the original BOD data were also adjusted to whole-day BOD values. This was done by graphic interpolation using semi-logarithmic graph paper. Using the plotting technique of Orford and Ingram (3) the observed BOD values were plotted on the linear scale against time on the logarithmic scale. The two values nearest the desired whole-day time interval were connected by a straight line and the BOD value for the whole day was read. In most cases, the interpolation involved only 0.3 days or less and had no effect on the statistical accuracy of the BOD values used. Approximately 16 per cent of the BOD values required adjustment to whole-day values.

In the study, 44 individual BOD tests were carried out for each of the 6 combinations of time and temperature. These 44 tests were made on 14 different sewage samples which were taken from 6 different treatment plants handling domestic sewage. Thus, each sewage sample obtained was divided into 2 to 4 portions for the individual BOD tests. The replication of samples was necessary so that the reproducibility of the BOD test could be determined for each time period and temperature studied.

The testing was done during the summer months under dry weather flow conditions. Grab samples were obtained during the daytime. The raw sewage samples were filtered through glass wool and BOD analyses were made usually within three hours after sampling. On occasion samples were stored overnight in a refrigerator.

The results were subjected to various statistical tests to determine: (a) whether the sampling was random and unbiased, (b) whether the data were normally distributed, and (c) the coefficient of variation for the various mean values. At the 95 per cent confidence level, all the data were determined to have a random distribution. Also, the data were found to follow a normal distribution curve by applying the chi square test and by plotting on normal probability paper.

Results

Five-day BOD values for the 44 domestic sewage samples ranged from 66 to 423 ppm and averaged 261 ppm. The coefficient of variation for the BOD values obtained are given in Table III. The lowest value of V was 3.9 per cent for the standard 5-day test, and the highest value was 8.4 per cent for the 1-day 37°C test. At 37°C, the V is

TABLE III.—Relationships Between Short-Time BOD and Standard 5-Day BOD of Domestic Sewage

Days	Temp. (°C)	V* for BOD's Determined (per cent)	Ratio of Short-Term BOD to 5-Day BOD (per cent)	V* for Ratios of Short-Term BOD to 5-Day BOD (per cent)	V* for 5-Day 20°C BOD Computed from Short-Term BOD (per cent)
1	20	8.2	47.4	9.1	12.6
2	20	4.9	68.8	6.2	7.5
3	20	4.6	82.0	6.0	7.1
1	37	8.4	69.4	9.2	13.0
2	37	5.6	92.3	6.8	8.6
5	20	3.9	—	—	—

* Coefficient of variation.

higher than for the corresponding 20°C test. Thus, there is no improvement in the reproducibility of the shortened test by using higher temperatures. Evidently, any gain in reproducibility, by using higher temperatures and reaching the flatter portion of the BOD curve sooner is offset by greater variations inherent in the use of higher temperatures.

In order to predict the 5-day BOD from a shorter test, it is necessary to determine the relationship between the two BOD tests. The ratio of the short-time BOD to the 5-day BOD is given in column 4 of Table III, and the V for this ratio is given in the next column. The ratio of 47.4 per cent for the 1-day 20°C test is significantly higher than the 41 per cent derived by Orford and Ingram from their BOD curve for domestic sewage. The ratios of the 2- and 3-day BOD values to the 5-day (20°C) BOD value, or 68.8 and 82.0 per cent, are very close to the values reported in the literature cited. In the 37°C BOD tests the ratios of the 1- and 2-day BOD values to the 5-day 20°C BOD value were 69.4 and 92.3 per cent, respectively.

The coefficients of variation, V, for the ratios (Table III) were computed according to the mathematical relationship that the coefficient of variation of any ratio equals the square root of the sum of the squares of the individual coefficients of variation (Equation 3).

$$V_{a/b} = \sqrt{V_a^2 + V_b^2} \quad \ldots\ldots (3)$$

Therefore, the V of a ratio is higher than the Vs of the individual terms.

For the 1-day 20°C BOD the V for the ratio was 9.1 per cent; 2-day and 3-day values were 6.2 and 6.0 per cent, respectively. At 37°C, these coefficients of variation were 9.2 and 6.8 per cent for the 1- and 2-day BOD ratios.

With the ratios for the short-time BOD to the 5-day BOD it is possible to estimate the 5-day BOD by dividing the short-time BOD by the ratio expressed as a decimal fraction. Thus for 2-day 20°C BOD values the

$$\text{5-day BOD} = \frac{\text{2-day BOD}}{0.688} = 1.45 \times \text{2-day BOD}.$$

Table III also gives the values of V for the 5-day BOD computed from the short-time BOD test values.

At 20°C, these V values for calculated 5-day BOD's were 12.6, 7.9, and 7.5 per cent for the 1-, 2-, and 3-day determinations, respectively. At 37°C, the corresponding V values were 12.5 and 8.8 per cent for 1- and 2-day BOD determinations. The values can be compared with the V of 3.9 per cent for the 5-day 20° BOD determinations made in this study.

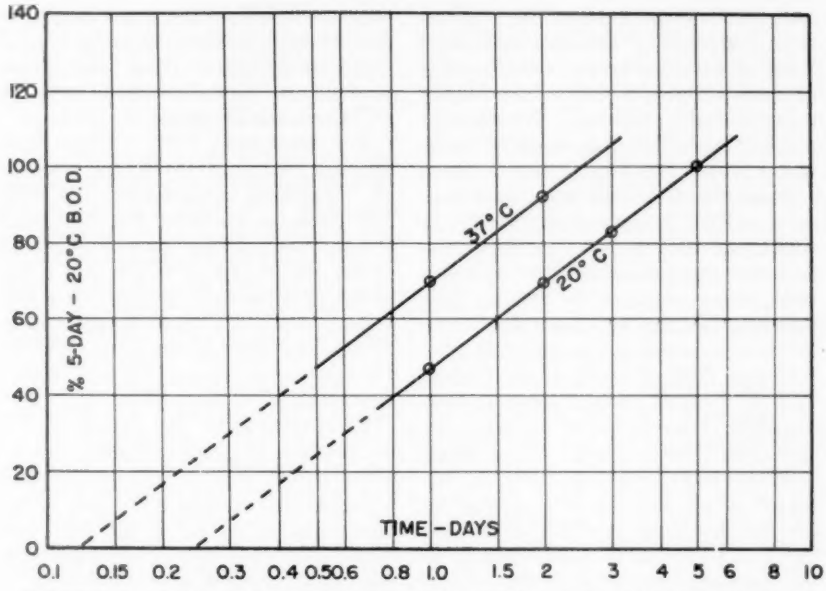

FIGURE 1.—Relationship Between Short-Time BOD and Standard 5-Day BOD of Domestic Sewage.

If the results of a short-time BOD test were used to predict a 5-day BOD value, it would be desirable to have conversion factors for any time interval, so that the test would not have to be finished on exactly whole-day intervals. Figure 1 shows the BOD ratios determined from this study plotted on semi-logarithmic paper. The straight lines of best fit were determined by the method of least squares according to the equation

$$Y_t = m \log t + b \ldots\ldots (4)$$

For the BOD values at 20°C, the equation of the line is

$$Y_t = 75.04 \log t + 46.84 \ldots (5)$$

and for BOD observations at 37°C

$$Y_t = 75.04 \log t + 69.43 \ldots (6)$$

where

Y_t = ratio of BOD at time observed to BOD at 5 days 20°C, expressed as per cent, and

t = time of BOD observation, days.

Ratios computed from these equations will be reliable between 0.8 and 7 days at 20°C, and between 0.6 and 4 days at 37°C.

The computed curves do not pass exactly through all the observed points. Table III gives the observed and computed ratios of the short-time BOD to the 5-day 20°C BOD (columns 3 and 4). The factors to convert the observed short-time BOD to 5-day 20°C BOD are given in columns 5 and 6. The computed factors are near enough to the observed ones that it is possible to use the factors computed from the equations without appreciably affecting the reliability of the computed 5-day 20°C BOD as shown in Table III.

The oxidation rate constants of the computed BOD curves are greater than those generally reported in the literature for domestic sewage. Using the logarithmic BOD formula (Equation 2), the a value for the 20°C curve (Figure 1) is 1.40 and the S value is 87.6. For the 37°C curve, the a value is 2.80

and the S value is also 87.6. Orford and Ingram (3) had assumed an a value of 1.0 for domestic sewage. The corresponding k_1 and L values for the monomolecular formula (Equation 1) are 0.24 and 104.5 for the 20°C curve and 0.48 and 104.5 for the 37°C curve.

Thus, the BOD oxidation rate constant at 37°C is twice that at 20°C. It was found earlier (3) that the oxidation rate constants at 30°C are also twice those obtained at 20°C. This indicates that the maximum BOD rate constant is between 30 and 37°C.

Gotaas (10) reported on three series of BOD tests of sewage made at temperatures from 5 to 40°C, using bicarbonate dilution water. The maximum oxidation rate constants, k_1, occurred at 25, 30, and 35°C, giving an average maximum k_1 value of 0.27 at 30°C. Analysis of the data taken from the individual curves gave the following average BOD values: 2-day at both 37° and 30° = 157 mg/l, and 4-day at 20° = 153 mg/l.

The work of Gotaas (10) also tends to show that for 2-day incubation the BOD values at 30 and 37°C are the same, and that at 20°C the 4-day BOD is equal to the 2-day 30°C BOD. This again confirms the observations that the oxidation rate at 30 and 37°C is twice the rate of oxidation at 20°C. Also confirmed is the observation that the maximum rate of oxidation is obtained between 30 and 37°C.

Discussion of Results

For domestic raw and primary settled sewage the 20°C BOD test can be shortened to 2 days without serious loss in reproducibility of the test. At 2-day incubation the coefficient of variation is increased only about 25 per cent over that for the standard 5-day test. The variation in a 1-day test can be expected to be about twice the variation of a standard 5-day test. Thus, for general BOD information the incubation time can be shortened to 2 days without seriously affecting the reproducibility of the test. For plant control work, where the advantage of quick results may offset any disadvantage in reproducibility, a 1-day BOD test can be used.

For short-term BOD testing, there appears to be no advantage in using an incubation temperature of 37°C. Variations in the 37°C test for 1 and 2 days are slightly greater than the variations in the 20°C test for corresponding incubation periods. If a laboratory has a 37° bacteriological incubator, then the expense of a 20°C incubator can be saved by use of the short-term 37°C BOD test.

Short-term BOD test values for domestic raw or settled sewage can be converted to 5-day 20°C BOD values by using the conversion factors given. The variation in the 2-day BOD test values combined with the variation in the factor tends to give a variation in the calculated 5-day 20°C BOD value about twice that of the 5-day 20°C test itself. This variation is increased by three times when the 1-day BOD test is used to calculate 5-day BOD values.

The relationships between the short-term BOD test and the standard 5-day BOD test given in this paper are not reliable for wastes which have an oxidation rate appreciably different from that of raw domestic sewage. These wastes could include biologically treated sewage effluent, sewage with high industrial waste content, and industrial wastes. In the case of biological effluents and some industrial wastes where there is no lag period in the BOD test, the relationship between a short-time BOD and the standard 5-day BOD can be experimentally determined and used to estimate the 5-day BOD value. With industrial wastes where a BOD lag is involved, better results from a short-term test might be obtained by using a 2-day 37°C BOD test. Here the 2-day value is almost equal to standard 5-day 20°C BOD value and the effect of biological lag on the tests should be approximately

the same. For plant control the short-period test can be used without conversion to 5-day 20°C BOD values.

Summary and Conclusions

A study was made to compare the results of short-term BOD tests to those of the standard 5-day 20°C BOD test. In the short-term tests, standard procedures were used except that the incubation time and temperature were changed. Tests were made for 1, 2, 3, and 5 days at 20°C and for 1 and 2 days at 37°C.

It was found that the variation in the BOD test increased as the incubation was shortened and the temperature increased. At 20°C, the 2-day test had a variation only 25 per cent greater than the 5-day test, while for the 1-day test the variation was doubled. No improvement is obtained at 37°C because the variation at 1 and 2 days is slightly greater than the variation for the corresponding incubation periods at 20°C.

The relationships between the short-term and 5-day 20°C BOD values are given so that the 5-day 20°C BOD value can be estimated raw and settled domestic sewage from a short-term test. It was found that the 5-day BOD values estimated from 2-day results had a variation about twice those from a standard 5-day 20°C BOD test. The variation increased to three times when the 5-day BOD was estimated from 1-day results.

It was concluded that for domestic raw and settled sewage:

1. The BOD incubation period can be shortened to 2 days without seriously affecting the reproducibility of the results.
2. The BOD incubation period can be shortened to 1 day and the results will be satisfactory for plant control purposes.
3. A short-term BOD test using an incubation temperature of 37°C has no better reproducibility than short-term tests at 20°C.

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Industrial Wastes

WATER RESOURCES AND INDUSTRIAL MANAGEMENT *

By W. H. Schuette

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The purpose of this paper is to discuss briefly the broad topic of water conservation from the point of view of an industrialist. It is not expected that the viewpoints and fundamental principles expressed herein will be new or in any way unfamiliar to those who are actively engaged in the sewage and industrial wastes field. It is believed, however, that they are so definitely pertinent to the successful future of industry and our water resources as to merit frequent and thoughtful reconsideration and study. The problems of water conservation become more pressing and acute as time goes on and it is therefore appropriate and very necessary to increase and augment the efforts which are being made to solve them.

The views of the author can be summarized in three sentences as follows:

1. Industry and the public agencies inevitably will, and eventually must, see eye-to-eye in their approach to conservation of water resources.

2. Industry as a whole is conscious of its obligation to be a good corporate citizen and is doing something about it.

3. The public agencies also have a serious obligation to provide objective, cooperative leadership.

Necessity for Cooperation

The interests and viewpoint of the industrialist must eventually become similar to, and be in fundamental agreement with, the interests and viewpoints of the public agencies—federal, state, and local. It would appear absolutely predictable that the joint interests of industry and the public agencies will be accounted for in a mutually reasonable fashion.

Certain major factors seem to make it obvious that industry and the various public agencies have a mandate from the public at large to cooperate effectively. It is generally agreed that total water resources remain about the same from year to year. It is also known that the population is increasing at an inexorable 1½ per cent per year. The companion prediction of increasing industrial activity is also a certainty of the future. This set of facts invites their expression with the precision of an algebraic equation:

Expanding population + Expanding Industrial Activity = Increased Pressure on a Fixed Water Resource.

It is not necessary to cite the available statistics to support the theme that every future year will be one of increasing pressure on our water supply. This viewpoint was dramatically expressed by Dr. L. E. Burney, Surgeon General of the Public Health

* Presented at the 31st Annual Meeting, Federation of Sewage and Industrial Wastes Assns.; Detroit, Mich.; Oct. 6–9, 1958.

Service, U. S. Department of Health, Education and Welfare, as follows:

> As populations and industries continue to close the gaps between major sources of pollution along our rivers, we can look forward to nothing less than continuous streams of sewage and industrial waste instead of streams of useable water.

While all will not agree completely with this dreadful forecast of Dr. Burney's, it is hardly possible to disagree with the sense of his warning and with his concept that water becomes a dramatic commodity only when it is lacking.

It seems obvious that the increased pressure on the water supply translates quickly into increased pressure on industry and on the public agencies, which may be likened to stewards, jointly bearing the burden of working together to achieve a solution. The public must depend on them to measure up to this challenge and the possibility of failure is inadmissible. This sounds like saying that the problem will be solved merely because it has to be solved. Many do have this concept—that the need for a solution is so great that men of good faith and judgment simply must, and therefore can, work out an answer. However, such faith is not just blind faith. Technical preparedness is superb in this country and there are many indications that there is a growing awareness of the need for important improvement in attitudes.

The elements involved in this problem of water, its use and conservation, are tremendous. But the extreme dependence of the public and industry on adequate water supply is so dominating that there is no other answer than for industry and the public agencies to evolve an equitable solution.

Industrial Effort

Industry, in general, is striving to become a responsible, good corporate citizen with respect to the natural resources of the nation and the handling of waste. It is to be incumbent on industry to conduct itself in a becoming manner in this area. By doing so it will avoid the coercion of bad laws and all of the sad connotations that will inevitably follow if industry and the public agencies do not get together on a mutually reasonable basis.

Every industrial company of any stature has a very significant amount of effort allocated to the minimizing of its waste and consequent control of pollution of the water and air of its surrounding territory. A quick survey of the chemical industry reveals that approximately four per cent of its invested capital is devoted to minimizing waste and to control of pollution of water or air. Efforts along these lines at Dow Chemical Company are probably representative of the industry as a whole—which has a lot at stake. At Midland there are wastewater treating plants with an equivalent capital investment of more than $6 million and waste-burning facilities accounting for more than $2 million capital. Additional related waste control and pollution control facilities bring the total investment to more than $10 million. These facilities have permitted Dow to expand Midland from a $30 million plant investment in 1936 to more than $250 million in plant investment in 1958.

However, the limitations of wastewater treatment are becoming more apparent. In some areas the water resources are insufficient to meet the needs, even if all wastes were to be given "complete" treatment. Last summer, in Michigan, a very heavy rain early in July resulted in flood conditions. The higher flows received during the summer were welcome from a heat-exchange standpoint but the lowered oxygen, due to organic matter from land wash, left little oxygen which could be utilized all summer. The main river normally is turbid and has such a sandy, shifting bottom that

algae or aquatic weeds cannot grow to build oxygen.

This sort of situation leads to the belief that, in the near future, the so-called "natural purification" powers of many rivers may no longer be available to municipalities and industry since they will be needed to combat "natural" pollution. More urbanization, more hard-surfaced roads, more concentrated fertilization, more storm sewers and ditches—all of these lead to more "natural" pollution. This, in spite of the disappearance of the horse!

Perhaps there will be a necessity for artificial aeration of the rivers themselves. The only other answer, in such a situation, would be to augment the critical flows. The industrial manager would, in this case, find growth impossible without the collective efforts of other interests in the watershed. Again the cost of water would increase.

Management at Dow Chemical Company is keenly aware of the need for giving a lot of attention to proper conduct with respect to water. It is necessary to be conservative in the use of water because water is not too plentiful. It is also necessary to be careful of the disposal of water to avoid excessive pollution of the local river. In the latter endeavor, there are the interests of the sportsmen-fishermen to be remembered, on the one hand, and the good advice and corrective guidance of the Michigan Water Resources Commission, always at the other hand.

Dow is not unusual or exceptional in its respect for the need for conserving water and in its recognition of the very proper regulatory function of the public agencies. A very significant segment of industry does sincerely try to behave very properly and attempts to cooperate completely with the public agencies and to comply with their regulations. This is long-range self-preservation; this is good public relations; this is good management.

In addition to the basic urge to be a good citizen which motivates industry, there is a second motive for its good behavior with respect to water conservation. This is the practical realization of the legal aspects of pollution control. Many industrial managers feel that they have little opportunity to speak on the laws which regulate their behavior with respect to the conservation of water resources. This attitude is best illustrated by a wry remark attributed to one of them to the effect that "about all the industrial spokesman can say in this matter is 'Good Morning, Judge.'" However, things are not really this bad. Increasingly, legislative committees are inviting participation of representative industrial management to aid in the framing of laws and regulations. While not every industrial manager can personally have this opportunity, the thing that each of them can and should do is to become thoroughly conversant with the ground rules under which he must operate. He should not only know the laws, but know the people who administer them.

Relative to the legal aspects of the problem, it is interesting to note that the philosophy of considering all surface water as public water or "state water" is becoming more generally accepted. Laws written with this concept in mind protect the individual riparian right as well as the public interest. Industry policy has adjusted to this concept. The statutes superimposed on the riparian law are becoming more uniform, not only in the laws themselves but also in their administration. There is no longer a great difference in efficiency of enforcement, and therefore the competitive advantage of certain locations over others, with respect to cheap waste disposal, is rapidly disappearing. Compacts, such as that administered by the Ohio River Valley Water Sanitation Commission, are enabling great progress to be made toward comprehensive, uniform control. It is also true that the federal law, administered by the Public Health Serv-

ice, is designed to achieve uniformity of state action.

The permit system may be workable as an effective means of control provided that the limitations of its application are understood. Dow Chemical Company has applied for these permits in several states in connection with disposal of wastewaters from new processing plants. There is, however, a lack of fundamental knowledge which gives rise to questions no scientist can answer. For example: "What effect does 2 ppb of zinc have on the fecundity of the oyster?" One fisheries expert stated that most of his time is spent in answering questions which were psychological rather than technical.

After applying for preliminary approval for a permit, it is necessary to obtain approval of final plans. The control agency engineer reviews the plans for the treatment or control system and must report to the regulatory agency as to whether or not he thinks the system planned will protect state waters. There is an opportunity for a big difference of opinion here. The industrial waste treatment plant design may not resemble a sanitary sewage design. For example, some facilities are designed for a life of not more than five years. These units must be quickly expandable and even expendable. Half of the chemicals marketed today were not known twenty years ago. Waste treatment units must be built to anticipate a complete change of process or product. The industrial manager is responsible, not only for the design of these units, but for their operation and for any unlawful pollution. He must have a flexible system that can be quickly expanded, moved, or modified in a major fashion.

While most industries are attempting to do a good job in the area of water resources conservation, it must be admitted that there probably is a fairly large number of cases of industrial abuses of public water resources. But there is also a growing readiness on the part of industry to face up to and live up to its responsibility in this area. Failure to do a good job will intensify the problem and bring on a wave of bad, restrictive laws and crippling regulations.

Role of Public Agencies

The public agencies have a very special role. It is at once demanding, difficult, and complicated. The very nature of water—a resource desperately needed and sought after from all directions—makes the job of equitably husbanding this valuable commodity a responsibility of major magnitude. The problem calls for leadership of a very high type from the public regulatory agencies. To be really successful, this leadership must be devoid of political domination, and must be founded on an understanding of facts and their objective, intelligent analysis.

The public agencies are confronted with this sort of picture. On the one hand, they have the industrial body needing to use the water resources and these needs, in some cases, may be or may appear to be, in conflict with the public interest. On the other hand, they have the public wanting, and sometimes insisting on, a complete restriction of water to public recreational-type use. The public agencies have the serious problem of recognizing that industry must be able to grow and that public needs for recreation and other purposes must be properly protected as well. The basic needs of the nation's future demand that industry be able to grow. Provisions for protecting the recreational and public use of our water resources are equally important. This calls for objective, farsighted leadership on the part of the public agencies.

Industry is entitled to expect and to receive this type of leadership. Industry is entitled to be free from improperly-based laws or crippling regulations that can only produce results which are not in the best interests of

the public. Industry is entitled to genuine cooperation and realistic, practical attention to its problems. Anything less will be harmful and will retard progress. However, in return for its expectation of far-sighted, objective, intelligent, non-political leadership, industry must expect to give *quid pro quo*.

First, obviously, industry must be sure its own house is in order. Industry must be prepared to allocate an increasing amount of effort and capital to the conservation of water and the prevention of harmful pollution. Industry must adjust to the idea that this is one job that will never be completely finished, and that the water problem will be an increasing burden on its operations. In short, industry should be making serious plans to do a better job than it is doing today because, while today's conditions demand that a good job be done, the needs of tomorrow will demand much more from industry.

A second contribution that industry should be ready to make is that of giving support and cooperative assistance to the public agencies. There are so many ways in which this support can be extended that they need not be enumerated. It may be helpful, however, to describe a problem, recently encountered at Dow Chemical Company which serves to illustrate, to some degree, one of the many ways that industry must be cooperative if it wishes to have its interests properly advanced.

About a year and a half ago Dow became interested in establishing an operation at a location south of Midland. The operation contemplated the use of a nearby river for the controlled release of extremely dilute brine. The problem and plans had been thoroughly discussed with the state agencies, and there had been understanding, goodwill, and general acceptance. The local community was most anxious to have Dow locate in the area since it represented welcome tax revenues and employment opportunities. Everything seemed proper and in order.

However, at this time certain other groups viewed the project with alarm. Their objections were based on the possible effects of the anticipated amount of salt discharge to the fresh surface water. To those at Dow who had studied the problem it seemed reasonably certain that the expected salt concentrations would not be harmful, but irrefutable proof of this could not be offered. To obtain such scientific proof of the complete safety to fish, game, and wild rice of the project would have taken months or years, and this time was simply not available. Consequently, Dow elected to withdraw the proposal, to the keen disappointment of the actual residents of the area.

In the end this turned out to be a good thing for Dow because it forced the exercise of additional ingenuity at Midland and the necessary addition was accomplished there. However, the point is that Dow Chemical Company presented what it considered to be a complete, carefully prepared plan, but even though the cooperation of the public agencies was extended freely, questions arose to which Dow could not give all the answers which appeared to be needed.

It is not suggested that industry be expected to account completely for every possible or imaginary point, but industry must be prepared with extensive supporting data and scientific information so that its case may be intelligently supported by the public agencies. The agencies, in their turn, must frequently be prepared to do a job of explanation and education with interested groups, some of which may, at times, be difficult.

Industry should also be attentive to the value of jointly-supported research efforts with the public agencies in the area of water resources. This type of effort is needed now and more will be needed in the future.

The public agencies have a leadership

role demanding a sophisticated, intelligent approach, of a persuasive objective nature rather than of a coercive, restrictive type. To deserve this, industry must make equally important complementary, helpful contributions.

Summary and Conclusions

It is certain that the problems of water conservation will become increasingly acute as time goes on. The key to their successful solution, it seems, in an aggressive, cooperative effort carried on by industry and the public agencies. There are many problems to solve before a completely equitable situation can be attained. Further progress will depend on, and of necessity wait on, an increasing awareness, a growing enlightenment, and more effective attention to the problem by both industry and the control agencies. It is encouraging to note that both groups are becoming aware of their respective roles. If this trend continues—and it must continue—more definite signs of progress should be evident in the near future.

SMITH NEW BDSA ADVISER

Luther L. Smith, Executive Vice-President of Smith-Blair, Inc., South San Francisco, California, was recently named Adviser to the Director, Water and Sewerage Industry and Utilities Division, Business and Defense Administration, U. S. Department of Commerce.

Mr. Smith is on loan from his company to serve a temporary duty tour. He also becomes available for the National Defense Executive Reserve which would be called on to staff the operation of an emergency production agency in event of hostilities involving this country.

BASIC PETROCHEMICAL PROCESSES AS WASTE SOURCES *

By W. L. Ruggles

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This is one of several papers from an Industrial Wastes Symposium, titled "The Petrochemical Industry." Other papers in this series will appear in early issues of This Journal.

As related to the petrochemical industry, this paper (a) defines what petrochemicals are, (b) describes some of the basic petrochemical processes, and (c) discusses some of the wastes resulting from their manufacture.

The term "petrochemical" is a comparative newcomer to the English language. In fact, it does not even appear in some dictionaries and considerable confusion exists as to what it includes. Before defining "petrochemical," however, it would be well to define another term that is closely associated with it—hydrocarbons. Hydrocarbons are those compounds consisting solely of the elements carbon and hydrogen (1). For the purpose of this discussion, then, "petrochemicals" will be defined as those compounds which are derived in whole, or in part, from petroleum and natural gas hydrocarbons and which are used mainly in chemical markets rather than being primary sources of fuel and lubricants (1)(2)(3).

While defining terms it should also be explained what is meant by a "basic petrochemical process." It is believed that this term has not been defined previously. It will be applied to those processes that use previously unreacted hydrocarbons obtained from oil and gas by physical separation methods, or equivalent hydrocarbons produced by chemical reaction, or their impurities, to produce new chemicals. These chemicals may be used in the form produced or they may be reacted further to make related chemicals. The manufacture of ammonia is an example of a "basic petrochemical process" in that the hydrogen used can either be obtained from methane or as a side product of a cracking reaction. Also, ammonia is frequently used in the form produced or it may be incorporated in fertilizers, acids, etc.

Petrochemical Industry

Much of the confusion regarding what constitutes a petrochemical is caused by the fact that many hydrocarbons are used for both fuel and chemical purposes. Additional confusion results from the knowledge that some chemicals produced from petroleum or natural gas can also be derived from other materials. Butadiene is an example of this in that it was produced from grain and molasses alcohols during World War II as well as from petroleum components. Depending on the definition of petrochemical being used, estimates of the quantity of petroleum required to manufacture such compounds range from about 1 to 5 per cent (4)(5).

* Presented at the 31st Annual Meeting, Federation of Sewage and Industrial Wastes Assns.; Detroit, Mich.; Oct. 6–9, 1958.

Petrochemical manufacturing provides a means for profitable upgrading of raw materials, including sulfur compounds and others previously regarded as wastes, with little or no disruption of the flow of oil and gas to older and higher volume markets. This accounts for much of its popularity with the petroleum industry.

Although it probably was not realized at the time, the foundation for the petrochemical industry was laid when man first learned how to distill oil into fractions. The industry started gaining momentum in the 1920 to 1930 era when it was learned that hydrocarbon molecules could be altered by the application of heat and pressure to produce other hydrocarbons. These developments, and others of similar importance, resulted in the production of more and better gasolines from a given quantity of crude oil. Also, the know-how obtained soon resulted in the manufacture of synthetic fuels and alcohols and ultimately in the production of the many related chemicals that are available today (6).

Most people, including many of those employed in the petrochemical industry, fail to appreciate fully the impact that petrochemicals have had in recent years. It is pointed out that over 60 per cent of the new rubber and 95 per cent of the resins and plastics produced at the present time are derived from petrochemicals (7). Fabrics such as nylon, dacron, and orlon are produced from petrochemicals. Plastic pipe, dishware, toys, building materials, solvents, paints, varnishes, fertilizers, detergents, refrigerants, insecticides, antifreezes, and many drugs are among the multitude of products made from petrochemicals (8).

Petrochemical production has been doubling about every five years since 1945. At the present time, industry in the United States has between $4.5 and $5.0 billion invested in petrochemical manufacturing facilities and the annual value of chemicals produced by these plants is in the same $4.5 to $5.0-billion bracket. This is about 25 per cent of the value of all chemicals produced yearly (2)(7)(9). Most authorities expect that the tremendous growth indicated by these statistics will continue at essentially the same rate. This means that those concerned with petrochemical process design and pollution abatement have a tremendous task ahead.

Petrochemical Processes

Petroleum consists of three main types of hydrocarbons. The first, and most predominant, are the paraffins which include methane, butane, propane, etc. Next, are the naphthenes such as cyclopentane and cyclohexane and, third, the aromatics including benzene and toluene. The number of compounds possible from these three hydrocarbon groups are in the millions. However, from a processing and separation standpoint it is probably fortunate that petroleum contains relatively few of the many possible hydrocarbons. Natural gas is even better in that it contains between 85 and 95 per cent methane, 5 and 10 per cent ethane (both paraffins), and comparatively small amounts of higher molecular weight paraffin hydrocarbons (10). The relative simplicity of composition and the availability of natural gas accounts for a large portion of its popularity as a petrochemical manufacturing feedstock.

Four basic methods are used for separating individual compounds from hydrocarbon complexes to obtain pure feedstocks for petrochemical production as well as to isolate and purify the end products of the manufacturing processes (10). These methods are frequently used in combination and include the following:

1. *Distillation*, where separation occurs as a result of the hydrocarbons having different boiling points.

2. *Extraction* with solvents having selective preference for specific hydrocarbons or impurities.

3. *Adsorption* or *absorption* with materials having selective preference for specific hydrocarbons or impurities.

4. *Crystallization*, where process temperatures and pressures are adjusted and/or extractive materials used in such a manner as to solidify one or more of the components in the process stream.

These processes are similar to those used in oil refining. However, the fact that petrochemical manufacture frequently requires more steps and more selective equipment, as well as greater amounts of processing energy, usually results in higher plant investment and operating costs. The flow diagram shown in Figure 1 is for an actual butadiene plant and gives an indication of the complexity of many petrochemical manufacturing units. Although the capacity of this plant is only about 100 gpm, the facilities required to make this production occupy about 80 acres of land.

The typical reactions that can be

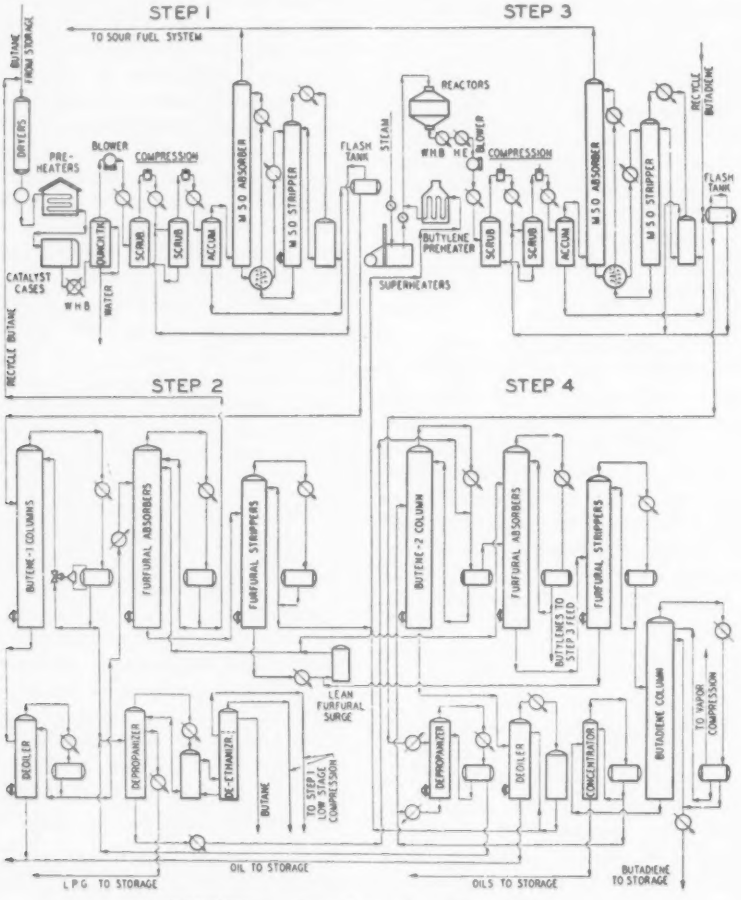

FIGURE 1.—Butadiene plant flow diagram.

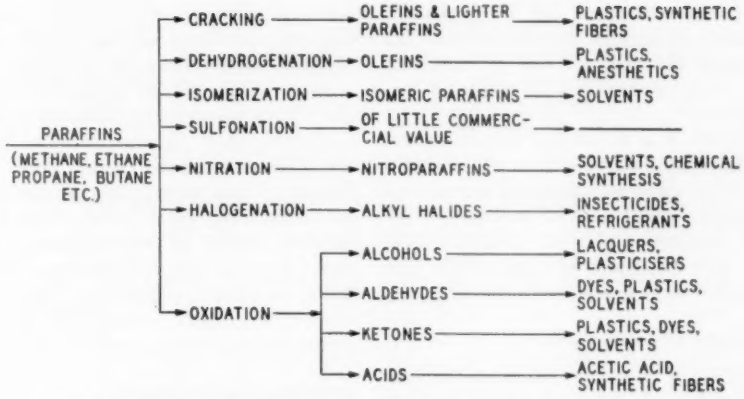

FIGURE 2.—Typical reactions of paraffin hydrocarbons and examples of chemical uses.

used to produce petrochemicals from paraffin feedstocks are shown in Figure 2 as are some of the commodities produced from these chemicals (1) (10). "Oxidation," "nitration," and "sulfonation" occur when the hydrocarbons are reacted with oxygen, nitric acid, and sulfuric acid, or with other compounds that will produce results similar to those obtained by these three reactants. "Halogenation" is the reaction involving a halogen such as chlorine or fluorine. "Dehydrogenation" entails removal of hydrogen atoms from hydrocarbon molecules. "Cracking" refers to the breaking of the bonds between the carbon atoms of a hydrocarbon molecule to produce molecules of other hydrocarbons. "Isomerization" is the alteration of the structure of a hydrocarbon molecule without changing the quantity of elements making up the original molecule. The naphthene and aromatic groups are susceptible to many of these same reactions, as well as several different ones, to produce a wide variety of interesting and useful chemicals.

Cracking, dehydrogenation, oxidation, absorption, distillation, and extraction are among the most widely used petrochemical production and purification methods. This discussion will, therefore, examine typical basic petrochemical processes where such methods are used and see what waste materials they may produce.

Butadiene Manufacture

The manufacture of butadiene from normal butane involves a typical dehydrogenation reaction. Referring again to Figure 1, this reaction takes place in the catalyst cases in the presence of catalyst and heat. After the process gas is quenched and scrubbed the separation and purification procedures begin in a mineral seal oil absorber. The hydrogen, methane, ethane, and carbon dioxide components of the dehydrogenated gas stream pass through the mineral seal oil and on to the fuel system. The butylenes, however, are absorbed by the mineral seal oil and must be removed by steam stripping. These butylenes are then fractionated in the butene-1 column of step 2 and the bottom product is separated by furfural extractive distillation. In the furfural absorber, furfural selectively extracts the butene-2 and these components are then separated in the stripping columns by distillation. Steps 3 and 4 are similar to steps 1 and 2 except that butene-2 is

dehydrogenated and the furfural distillation is specific for butadiene. In all cases the mineral seal oil and furfural are regenerated for reuse by distillation.

Figure 3 is a simpler flow diagram for butadiene manufacture which shows the basic process phases of a two-step butadiene plant as well as some of the side products and their possible uses. The side products are essentially the same for both types of plants.

Ethylene Manufacture

Figure 4 is a flow diagram for the production of ethylene. Except that cracking rather than dehydrogenation is involved, this process is similar to that for butadiene since they both have steps involving feedstock decomposition and means for separating and purifying the decomposition products. If butadiene, ethylene, and similar plants are parts of a large petroleum-petrochemical refining center, or if other markets are close at hand, the side products may approach the major product in value. In fact, by using different feedstocks and/or varying operating conditions, it is sometimes possible to manufacture one of the side products as the major item rather than the chemical originally intended. This ability to accommodate the whims of an unpredictable market is a real asset. Unfortunately, there are other instances where the side products, and even some of the main products, must be sewered. This may be the result of unsatisfactory by-product recovery economics, major spills, or simple pump seal leaks. In any event, such conditions usually necessitate pollution control measures.

Ammonia Manufacture

Figure 5 shows the flow diagram for the manufacture of ammonia from natural gas, air, and steam. This petrochemical is unusual in that it is one of the few not containing carbon. It is also the largest petrochemical in terms of quantity produced, with the 1957 production of 3.5 million tons being about 18 per cent of all petrochemicals manufactured (4)(11).

The reactions involved in the reform furnaces to produce synthesis gas are also somewhat unique since they exhibit characteristics of both

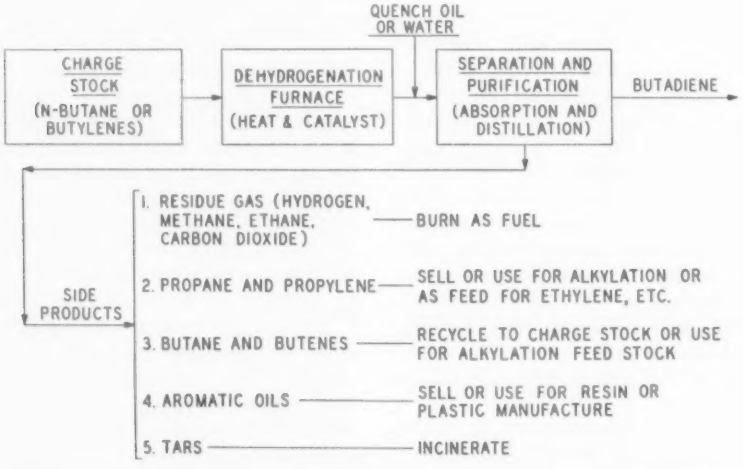
QUENCH OIL OR WATER
CHARGE STOCK (N-BUTANE OR BUTYLENES)
DEHYDROGENATION FURNACE (HEAT & CATALYST)
SEPARATION AND PURIFICATION (ABSORPTION AND DISTILLATION)
BUTADIENE
SIDE PRODUCTS
1. RESIDUE GAS (HYDROGEN, METHANE, ETHANE, CARBON DIOXIDE)
BURN AS FUEL
2. PROPANE AND PROPYLENE
SELL OR USE FOR ALKYLATION OR AS FEED FOR ETHYLENE, ETC.
3. BUTANE AND BUTENES
RECYCLE TO CHARGE STOCK OR USE FOR ALKYLATION FEED STOCK
4. AROMATIC OILS
SELL OR USE FOR RESIN OR PLASTIC MANUFACTURE
5. TARS
INCINERATE

FIGURE 3.—Flow diagram for manufacture of butadiene showing possible constructive uses for most side products.

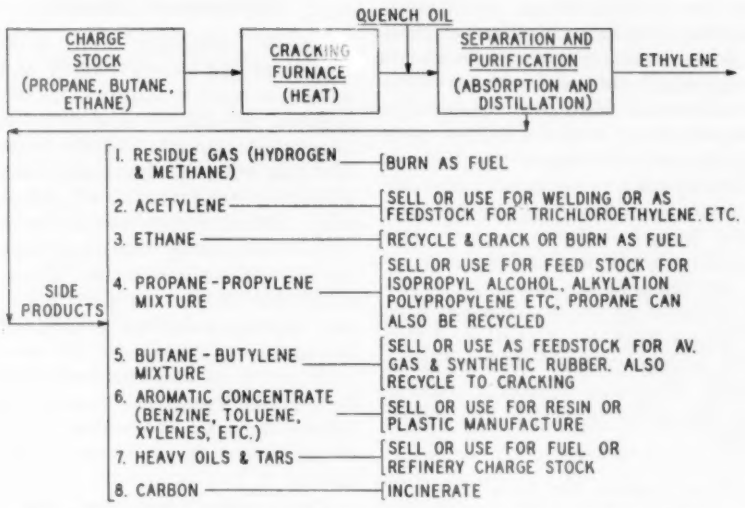
QUENCH OIL
CHARGE STOCK (PROPANE, BUTANE, ETHANE)
CRACKING FURNACE (HEAT)
SEPARATION AND PURIFICATION (ABSORPTION AND DISTILLATION)
ETHYLENE
SIDE PRODUCTS
1. RESIDUE GAS (HYDROGEN & METHANE) — BURN AS FUEL
2. ACETYLENE — SELL OR USE FOR WELDING OR AS FEEDSTOCK FOR TRICHLOROETHYLENE, ETC.
3. ETHANE — RECYCLE & CRACK OR BURN AS FUEL
4. PROPANE-PROPYLENE MIXTURE — SELL OR USE FOR FEED STOCK FOR ISOPROPYL ALCOHOL, ALKYLATION POLYPROPYLENE ETC. PROPANE CAN ALSO BE RECYCLED
5. BUTANE-BUTYLENE MIXTURE — SELL OR USE AS FEEDSTOCK FOR AV. GAS & SYNTHETIC RUBBER. ALSO RECYCLE TO CRACKING
6. AROMATIC CONCENTRATE (BENZINE, TOLUENE, XYLENES, ETC.) — SELL OR USE FOR RESIN OR PLASTIC MANUFACTURE
7. HEAVY OILS & TARS — SELL OR USE FOR FUEL OR REFINERY CHARGE STOCK
8. CARBON — INCINERATE

FIGURE 4.—Flow diagram for manufacture of ethylene showing possible constructive uses for most side products.

oxidation and dehydrogenation. In the reaction, $CH_4 + H_2O = CO + 3H_2$, the valence of carbon is changed from negative four to negative two, thereby exhibiting the characteristics of an oxidation reaction. However, both this reaction and the other one, $CH_4 + 2H_2O = CO_2 + 4H_2$, involve removal of hydrogen from methane which is characteristic of dehydrogenation.

The carbon dioxide and carbon monoxide removal steps of ammonia manufacture are also good examples of the use of absorption and fractiona-

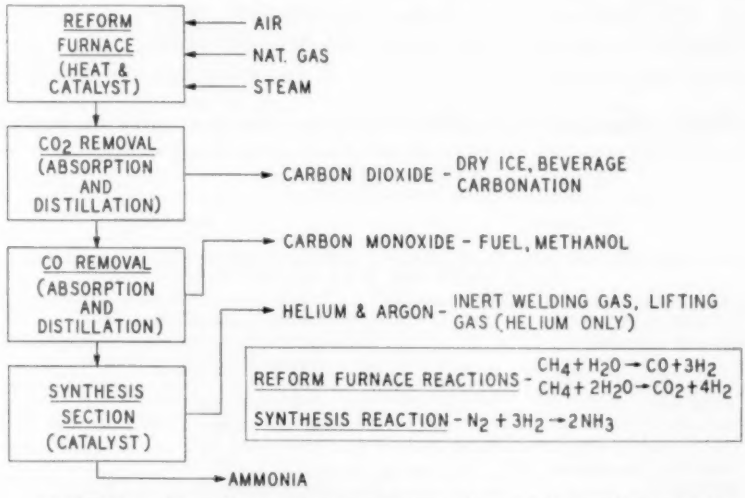
REFORM FURNACE (HEAT & CATALYST)
AIR
NAT. GAS
STEAM
CO_2 REMOVAL (ABSORPTION AND DISTILLATION)
CARBON DIOXIDE - DRY ICE, BEVERAGE CARBONATION
CO REMOVAL (ABSORPTION AND DISTILLATION)
CARBON MONOXIDE - FUEL, METHANOL
HELIUM & ARGON - INERT WELDING GAS, LIFTING GAS (HELIUM ONLY)
SYNTHESIS SECTION (CATALYST)
REFORM FURNACE REACTIONS - $CH_4 + H_2O \rightarrow CO + 3H_2$ $CH_4 + 2H_2O \rightarrow CO_2 + 4H_2$
SYNTHESIS REACTION - $N_2 + 3H_2 \rightarrow 2NH_3$
AMMONIA

FIGURE 5.—Flow diagram for manufacture of ammonia showing possible uses for side products.

tion for petrochemical purification. Monoethanolamine, potassium carbonate, and caustic are common absorbents for carbon dioxide, and ammonical cuprous formate solution is an example of an absorbent used for carbon monoxide removal. In some ammonia plants accidental spills of the ammonical copper formate solution may create a pollution hazard. However, even this possibility is eliminated in plants using low temperature separation methods for isolating process nitrogen from air because they use a portion of that liquid nitrogen for scrubbing carbon dioxide from the hydrogen stream. This eliminates need for the copper liquor.

Non-Hydrocarbon Materials

Although this discussion has dealt with only a few petrochemical processes and the principal hydrocarbon wastes they produce, it seems desirable that at least brief reference be made to some of the non-hydrocarbon contaminants produced by petrochemical manufacture. Table I shows a partial tabulation of such materials including some of the gases discussed above. It is noted that many of these materials come from the utility areas as well as from process.

Improvement Measures

Process efficiency and pollution abatement are closely related and the measures taken to improve one usually improve the other. The recycling of unreacted materials and the regeneration and reuse of absorbents discussed previously are examples of such measures. Another example is the use of oil rather than water for direct quenching of process gases and the subsequent use of that oil for fuel. Tars and similar materials removed from the gases by the oil do not interfere with its use as fuel but would have to be removed from waste quench water before they, or the water, could be disposed of without risk of stream pollution.

Three other measures that frequently benefit efficiency and pollution abatement are as follows:

1. Where water is the coolant, use shell and tube heat exchangers rather than barometric condensers and other units which permit process gases to contact and become absorbed in the water.

2. To minimize quantity of water sewered, use cooling towers which permit reuse of cooling water, rather than once-through systems.

3. Use active leak detection and cor-

TABLE I.—Typical Petrochemical Plant Wastes Other Than Hydrocarbon Side Products

Non-Hydrocarbon Contaminants	
From Process	From Utilities
1. Gases—CO_2, CO, H_2S, NH_3, N_2, H_2, etc.	1. Boiler blowdown—phosphates, lignins, heat, etc.
2. Spent caustic containing sulfides, mercaptans, etc.	2. Cooling system blowdown—chromates, phosphates, algicides, heat, etc.
3. Acids and acid sludges	3. Water treater blowdown—calcium and magnesium chlorides, carbonates, etc.
4. Spent catalysts containing iron, nickel, chromium, etc.	4. Oil and grease from mechanical equipment and quenching
5. Filter aids	5. Sanitary sewage
6. Solvents and absorbents—furfural, monoethanolamine, phenols, etc.	6. Storm water
7. Spent lime	7. Miscellaneous trash—shipping boxes, paper, cans, etc.

rection programs to eliminate losses of products and other materials that have value and/or contribute to contamination.

The petrochemical industry is similar to other industries in that management decisions regarding products to make and the sites at which they will be manufactured should, along with other factors, take into account possible pollution problems. When these decisions are made, process development and engineering personnel are given the responsibility of designing facilities incorporating the most feasible features contributing to efficiency and pollution control. Once the plant is on stream it is the responsibility of the operations group to put these features to best use. The suggestions and advice of competent governmental enforcement personnel, who will sit down with industry representatives and realistically evaluate the effect of waste effluents on receiving streams, have in many cases been very helpful in all phases of plant conception, design, and operation.

Acknowledgments

Appreciation is expressed to colleagues and supervisors in Phillips Chemical Company's Engineering Division for their helpful comments and advice and to the Phillips Petroleum Company's Engineering Department personnel for preparing the illustrations.

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NEW MANUALS OF PRACTICE

Journal readers are again reminded of the two new Manuals of Practice announced in the February issue. Manual of Practice No. 1, "Safety in Wastewater Works," is a 64-page revision of the early Safety Manual and is available immediately from the Federation office. Manual of Practice No. 8, "Sewage Treatment Plant Design," is a joint publication with the American Society of Civil Engineers. Orders for this manual are being received in the Federation office now. See page 130a of this issue for complete details for these and other available Federation publications.

RAPID TAX AMORTIZATION FOR INDUSTRIAL WASTE TREATMENT FACILITIES

By James J. Flannery

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Rapid tax amortization for the expenditures by industrial firms on waste treatment facilities related to water pollution control has been a topic for frequent public discussion for the past ten years. Interest in the subject is based on two closely related factors: the desire to ease the financial burden incurred by firms engaging in treatment plant construction; and the desire to provide an inducement for other industrial organizations to undertake such projects. The purpose of this paper is to examine the extent to which these objectives are actually served by rapid tax amortization. Consideration of the subject must start with the accounting and tax aspects of the problem, for rapid tax amortization involves a particular application of depreciation accounting to corporate income taxation.

Accounting for Depreciation

Sound financial management requires that some portion of the purchase price of tangible capital assets be charged as an expense during each year of the life of such assets. This procedure is necessary if a reasonable conclusion as to a firm's annual profit or loss is to be obtained. The expense situation would be distorted if equipment, machinery, or other capital assets were to be charged solely against the year of purchase. On the other hand, expenditures on machinery and equipment cannot be ignored to the extent that the expense accounts reflect only the cost of items purchased for consumption in one year. This problem is met through the depreciation account which is charged annually with a portion of a capital asset's value until that asset is either worn out or ready for salvage. Thus, for accounting purposes, the purchase cost of a capital asset is treated as a prepaid operating expense. The term, "depreciation" is often used as though it represented an annual decline in value because of use and deterioration. This impression is derived from the annual charge to this account and the consequent decrease in book value of the asset. Though this diminution of value may actually take place, the accounting objective is to distribute the cost in annual portions over the life of the asset; not to measure its value. Thus depreciation, or more properly capital consumption, is treated as a cost in the same way that expenditures for labor, fuel, etc., are treated. Grant and Norton (1) discuss this topic in detail.

Contrary to popular impression, the operation of a depreciation account does not provide funds for the firm, any more than does any other expenditure account. Only if a sinking fund, consisting of a bank deposit or similar investment for the segregation of certain funds diverted from income, is established along with the depreciation procedure are monies for the acquisition of new plant facilities made available in conjunction with depreciation.

This comparatively rare practice is discussed by Paton (2).

These introductory statements have been necessary to demonstrate that accounting for depreciation is a necessary part of financial management even without the impetus of taxation. No valid picture of net worth and net earnings or losses can be presented unless account is taken of capital consumption.

Income Taxation and Depreciation Accounting

Taxation of the net income of corporations has given new importance to the accounting for depreciation. Since depreciation constitutes a cost, it is deductible from gross income in the determination of net taxable income. The income tax laws, both Federal and State, usually prescribe the average life service of categories of depreciable assets and permit exceptions on prior arrangement between the taxpayer and the tax authorities. The laws also state the methods for computing the annual depreciation allowances. (In chapter 11, pp. 208–242 Grant and Norton (1) offer a historical, analytical treatment of depreciation in Federal income taxation in the United States.) It is to the interest of the taxpaying corporation, therefore, to handle depreciation accurately and to its best advantage within the limits set by the law. Poor accounting practice in this situation may result in an overstatement of taxable income.

Methods of Computing Depreciation

The Federal Revenue Act of 1954 broadened to some extent the allowances for depreciation by providing three additional methods for computing it besides the traditional "straightline" and other methods. Historical or initial purchase cost was continued as the depreciation base and no change was made in the depreciable life period of assets. The Act authorized depreciation computation methods that attribute the larger share of the cost apportionment to the earlier years of the asset's life. The term applied to this concept is "accelerated depreciation." The additional methods authorized by the Act are as follows:

1. The declining balance method which applies a constant depreciation rate to initial purchase cost less total depreciation already taken.

2. The sum-of-the-years digits method which results in a depreciation rate determined by dividing the number of years remaining in an asset's life by the sum of each of the digits in its life.

3. Any other consistent method which does not produce an accumulated allowance during the first two-thirds of the useful life of the property in excess of that produced as a result of application of the declining balance method at double the straightline rate.

These new methods were not designed to meet corporate financial problems associated with inflation or to improve the equity of the income tax. Rather, they were intended to speed the rate of economic growth. For this reason the Act provided that the methods were to apply to new assets with a life expectancy of three or more years. Brown (3) discusses this matter more fully.

Undoubtedly there is wide variation in the value of these new methods to industrial firms, depending on the physical assets and the financial situation of each. The effect on the economy is difficult to determine, although one financial analyst (3) states that it is "a costly method of getting a modest investment stimulus."

Inflation and Depreciation

Pleas for changes in depreciation allowances for tax purposes are made because of the inflation-produced discrepancy between the initial purchase, or historical, costs of assets and the reproduction costs. The pleaders

claim that current depreciation allowances are inadequate under inflationary conditions and that consequently net income computations reflect "phantom profits" (4).

To a large extent, these pleas represent a lack of understanding of depreciation accounting for, as has been shown, depreciation is handled traditionally as a prepaid expense and therefore the amount entered in the account is the actual purchase price. This amount is then written off over the life of the asset in whatever amounts are proper and correct. The achievement of the pleaders' objectives would require either an annual adjustment in the book value of each capital asset according to a purchasing power index or the writing off of the asset in less than its expected life. The result under either procedure would be to reduce income tax liability but the tax savings would have to be placed in an equipment replacement fund to provide the anticipated investment capital.

The tax authorities as yet have not acknowledged such pleas by general changes in the law, although the nature of the difficulty and the amendment of conventional accounting procedures have been discussed by leading professional accountants many times.

Rapid Tax Amortization

The depreciation policy established by the Federal Government during World War II and the Korean War was designed to induce investment in war production facilities and followed a different principle than did the acceleration provisions previously described. The wartime principle embodied a change in the depreciable life of certain assets, regardless of their expected physical life. That is, those assets deemed useful primarily for the war effort were allowed to be written off in only five years even though they might reasonably be expected to be operable for much longer periods. Thus, recognition was given to the handicap that industrial concerns might suffer if they invested heavily in plant and equipment of little or no economic use after the close of the war. This policy is known as rapid tax amortization.

Because of the importance of certain industrial operations to national defense, the rapid amortization provision was written into the Revenue Act of 1954, Section 168. The Office of Defense Mobilization administers this program and provides certificates of eligibility when certain objectives are met, such as the development of new technology or industrial expansion in new areas. The effect of rapid amortization is to reduce a firm's taxable income during the amortization period and consequently to increase internal funds available to the firm. There have been no recent pleas for general expansion of this feature of the tax laws. In fact, the Revenue Act was amended in August 1957, to provide for the expiration of the amortization feature on December 31, 1959 (P. L. 165, 85th Congress).

Incentive Effects

The extent of the incentive effect of rapid amortization is dependent on several factors. These must be considered on an individual firm basis because of the wide variety of financial and other circumstances which prevail. Some of the factors are:

1. Whether or not the firm feels that an economic operation of the facility can be expected beyond the period allowed by the rapid amortization. This factor is of prime importance when a firm expects only a temporary increase in demand for the product. Plant expansion for the production of war or defense material is the best example of this situation. This factor is also of importance when a firm is involved in operations subject to rapid, and possibly frequent, technological

changes that cause economic obsolescence of a facility. In such an operation, technological changes in the productive process may be developed that leave the facility in a competitively disadvantageous position long before the regular depreciation period expires.

2. Whether or not the resultant increase in internal funds is significant in amount in terms of the financial needs and plans of the firm. This factor is of importance primarily to the small or expanding firm.

3. Whether or not it is necessary for the firm to borrow funds for construction of the facility and whether the interest rate and acquisition of funds are favorably affected by the shorter borrowing period. This factor also would be of primary importance to the small and growing firm.

4. Whether or not the firm places a premium on financial liquidity and avoids long-term indebtedness. A firm that does so is more amenable to expansion that can be amortized rapidly. This factor would be of particular importance to a conservatively operated firm.

5. Whether or not the firm expects the income tax rate to decline after the depreciation period. This factor is probably the least important for it involves a large amount of uncertainty and offers the least possibility of potential benefit.

Application to Waste Treatment Plant Construction

Numerous measures have been introduced in Congress since 1947 to provide rapid tax amortization for industrial waste treatment facilities. These measures, in general, would allow rapid amortization only for actual treatment facilities. No rapid amortization allowance would be provided for expenditures made solely on plant-process changes even though they resulted in reduction of waste disposal to the streams. In other words, only an end-of-the-line waste treatment plant would be eligible, under these bills, for the rapid amortization allowance.

The proposed measures also provide that, if a treatment plant produces a valuable by-product, only that portion of the capital costs which exceeds the amount necessary to produce the by-product would be eligible for rapid amortization. In most instances this additional eligible increment would probably not be present in a waste treatment facility producing a valuable by-product. Therefore, it can be concluded that most income-producing treatment facilities would be eliminated from consideration. Another restrictive feature of the bills provides that only those plants constructed as the result of waste treatment orders from a State pollution control agency, and certified to the Federal Government as such, can be considered for the amortization allowance.

Due to the limitations inherent in the proposed measures, significant administrative problems would be incurred if they were to be adopted, particularly if a valuable by-product were involved. An inspection by competent engineers would be necessary for each installation. Thus, administrative costs of the program would probably be high.

The actual incentive effect of rapid amortization is difficult to estimate. This tax advantage device was designed, and has been used, to encourage certain kinds of profitable operations. The limitation of the proposed legislation to non-productive, non-income producing expenditures is in contrast to existing uses and seriously restricts the incentive potential. There would still be, however, some incentive effect, at least to the extent of reducing the resistance of firms to the idea of treatment works construction.

This incentive effect would be greatest in states where a strong enforcement program was operative against waste-discharging firms. In that case,

each of the factors previously discussed as being applicable to other forms of rapid amortization would pertain. For example, the incentive effect of a firm's expectation that a particular installation would have an economic life much shorter than the predicted physical life would also have a particular bearing in some waste treatment situations. Such situations would occur in the case of firms which change their product or their process frequently with the result that a waste treatment facility, designed for a particular purpose, might be rendered useless by the changes. In these instances, a short amortization period might make the construction of treatment facilities financially feasible. The smaller, less well-financed firm would be most likely to view rapid amortization favorably under the other factors listed. It is conceivable too that even the larger firms, especially those requiring costly treatment facilities, would also consider rapid amortization as an advantage.

State Experiences

At least three states—Wisconsin, Virginia, and North Carolina—have statutes providing for rapid amortization for waste treatment facility costs. In none of these states do the respective state pollution control authorities regard the legislation as being significant in the attainment of pollution control objectives. A mitigating factor in this conclusion is the comparatively low rate—2 to 6 per cent—of the corporate income tax in each of these states. Therefore, the impact of the amortization provision is reduced considerably. The 30-per cent and 52-per cent rates of the Federal corporate income tax, however, undoubtedly increase the attractiveness of rapid amortization proposals under Federal legislation.

Political Palatability

Apparently there is no opposition to the proposed measure among the interested groups concerned with Federal activities in regard to water pollution control. Conservationist groups have indicated their approval and industry, as represented by the U. S. Chamber of Commerce and the National Association of Manufacturers, has indorsed the proposal. The Treasury Department, however, has not so far approved the measure. Its refusal to do so has been based on the inconsistency of the proposal with prevailing fiscal policy, which has been to restrict rapid amortization and not to bestow further selective tax advantages. The detrimental effect on the revenues has also influenced the Treasury judgment.

Whereas rapid amortization for productive, profitable facilities may actually increase the revenues because of resultant expanded economic activity, this result cannot be expected from rapid amortization for waste treatment facilities which are non-productive and non-profitable. It may be that the benefit to the public interest from the abatement of water pollution may offset any decrease in Federal revenues, however. In May of 1958, the Federal Water Pollution Control Advisory Board, appointed by the President of the United States, recommended the passage of such legislation.

Alternate Possible Incentives

Two other possibilities exist for creating an incentive for industry to build waste treatment facilities.

One possibility would be to provide that a firm constructing a facility be authorized for income tax purposes, to write off the full cost in any one year of a five-year period beginning with the year of construction completion. Under this provision a firm would be able to choose the most favorable year from its earning standpoint and thus reduce its taxable income.

A second possibility would be to allow a firm to write off for tax purposes, an amount larger than the actual

expenditure on the treatment facility. The excess writeoff might be as large as 25 or 50 per cent, depending on what is regarded as desirable in the way of inducement. There is a provision in British tax law to this effect for certain types of new technological improvements (5).

Conclusions

Most economists agree that rapid tax amortization can provide an inducement to investment under certain conditions. The extent of the inducement is difficult to measure. In regard to waste treatment facilities for water pollution control, the element of uncertainty is larger than in less particularized instances because treatment facilities are not revenue producers. Since little is known about current annual expenditures for such construction, the effect on the Federal revenues, as well as the amount of increase in waste treatment construction, is impossible to calculate.

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NUCLEAR CONGRESS PROGRAM

The 1959 Nuclear Congress, with the Federation as one of the more than 30 sponsors, to be held in the Public Auditorium, Cleveland, Ohio, April 5–10, includes several papers on wastewater and water problems. The half-day session on Monday morning, April 6, devoted to wastewater problems, includes the following papers sponsored by the Federation:

"The Need for Biological Monitoring of Radioactive Waste Streams," by R. F. Foster.

"Thermal Considerations in the Storage of Radioactive Wastes in Salt Formations," by R. S. Schechter and E. F. Gloyna.

"Disposal of Radioactive Liquids From Nuclear Powered Ships," by James M. Smith, Jr.

The afternoon of the same day will offer papers discussing water problems.

Stream Pollution

THE ONTARIO WATER RESOURCES PROGRAM *

By A. E. Berry

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New legislation has been adopted recently in the Province of Ontario, Canada. The objective of this is an adequate supply of clean potable water to all communities under favorable conditions of finance and administration. It recognizes that the construction of sewage and industrial waste treatment plants is a key factor in the protection of the water resources of the Province and the advantageous utilization of these water resources. This legislation brings into being a new development, unique in Canada, and probably in most other countries today. This new program resulted from a number of factors which developed over a period of time.

Background

A better understanding of the program which is now in effect may be seen through an analysis of some of the conditions which brought about this change in policy. Ontario is the central province of the 10 which make up Canada. Of a total population in Canada of 17 million, Ontario has more than 5½ million spread over 412,582 sq miles while all Canada covers a total of 3,845,794 sq miles. This relatively scattered distribution of population creates problems where community projects are involved. Southern Ontario has the highest concentration of population and has been a focal point for industrial growth. Opportunities for growth in Ontario, both of industries and population, are tremendous, and to confirm this, expansion has been taking place in recent years at an unprecedented rate.

The part played by the Province of Ontario in the industrial activity of all Canada can be seen through statistics on the number of industrial employees, their total salary and wages paid, and the value of the factory shipments. In each of these figures, Ontario represents slightly less than 50 per cent of the total of all Canada. Logically, much of this activity is in the southern part of the Province where the greatest concentration of population and industry occurs.

It is recognized that growth and human betterment cannot be sustained unless adequate water supplies are available. These supplies are a great national asset, and the quality must be protected at all costs. The importance of the Great Lakes system to southern Ontario is clearly evident. Large communities and industries were attracted to these waters over a period of many years. Now, as the growth moves inland, the adequacy of water and the prevention of pollution take on new significance.

Inland communities in much of southern Ontario are faced with water problems including quantity, quality, and pollution control. Rapid runoff and resulting low stream flows in the summer months combine to make pol-

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lution a serious problem when these watercourses are needed for their normal functions. Costs for the development and transportation of water have risen sharply and high interest rates have added further to this difficulty. It is essential to protect local water supplies from pollution when the expenditures for other supplies are so great. When water must be piped long distances, or when the most economical arrangement is necessary in sewage and industrial waste disposal, there is an advantage in dealing with these on a regional basis for a number of municipalities rather than having each attempt to solve its own problems separately. Individual efforts in the past have not led to the most effective solutions to these problems.

By 1955, the need for water supply and sewage treatment works was sufficiently urgent to call for action at the Provincial level. This was especially true in southern Ontario where a major post-war growth had been experienced, and where there was every promise of a continuance of this expansion if no serious restrictions or barriers were placed in the way. Adequate water resources of good quality were recognized as a primary need for insuring this continued growth and the welfare of the Province. The close relationship between waste disposal and availability of water supplies was conceded in the program which was to be adopted by the Province.

Legislative Action

The adverse conditions which might develop in relation to water resources were foreseen by the Government of the Province, and a Water Resources and Supply Committee was appointed in 1955 to inquire into and to advise on a constructive program. The Committee consisted of five members under the chairmanship of Mr. A. M. Snider. The Committee's report of that same year was followed immediately by legislation made effective in April 1956, and through which a Water Resources Commission was appointed, consisting of five men under the same Chairman. This first legislative enactment authorized the development of an organization and necessary procedures for carrying out the program. This bill was considerably altered in April of 1957 under the title "The Ontario Water Resources Commission Act, 1957." Some further amendments were made in 1958. These various actions provided the means for the Commission to proceed aggressively on its objectives.

The Ontario Water Resources Act

The broad scope of the authority given to the Commission is set out in Section 16 of the Ontario Water Resources Commission Act.* The major features of this legislation may be considered under two parts: (a) one dealing with the supervision by the Commission over all water and sewage

* This part of the Act (c. 88, s. 16; 1957) reads as follows:

"Notwithstanding any other Act, it is the function of the Commission and it has power,

(a) to control and regulate the collection, production, treatment, storage, transmission, distribution and use of water for public purposes and to make orders with respect thereto;
(b) to construct, acquire, provide, operate and maintain water works and to develop and make available supplies of water to municipalities and persons;
(c) to construct, acquire, provide, operate and maintain sewage works and to receive, treat and dispose of sewage delivered by municipalities and persons;
(d) to make agreements with any one or more municipalities or persons with respect to a supply of water or the reception, treatment and disposal of sewage.
(e) to conduct research programmes and to prepare statistics for its purposes; and
(f) to perform such other functions or discharge such other duties as may be assigned to it from time to time by the Lieutenant-Governor in Council."

works in the Province, and (b) the other dealing with the construction of water and sewage projects by the Commission for municipalities and others. Some features of these two parts of the program are contained in the following discussion.

For many years the Ontario Department of Health under public health legislation had exercised supervision over water and sewage works built and maintained by municipalities or persons. This was similar to what was done in other provinces of Canada, and in most of the United States. Under The Water Resources Commission Act, legislation contained in The Public Health Act was not only transferred to the Commission, but was considerably expanded and altered to permit more effective control. This was especially so in relation to stream pollution.

The program for water and sewage works construction is a distinct departure from the procedures of the past. It is believed to be different from practices followed in other countries. The object was to help municipalities meet their demands for these utilities. The Commission offers financial advantages as well as expert technical assistance in the planning, construction, and operation of the works. This procedure obviates the need of the municipality to issue any bonds or to borrow any money for the works.

Construction Procedures Under the Act

The procedure followed by the Commission in its program of constructing these water and sewage projects has several new features not otherwise utilized in Ontario.

1. Any municipality is free to decide whether it wishes to do its own work, or whether it desires to place this under the Commission. The services of the Commission are available to any municipality, but there is no effort made to urge a municipality to place a project under the Commission. The chief desire of the Commission is to see that the work goes forward. If the municipality so requests it, an agreement is made between the corporation and the Commission under which the latter undertakes to design, build, finance, and operate the water or sewage project. A standard form of agreement is used, subject to minor alterations to meet local conditions. This agreement on a project may involve one or several municipalities as well as industries. It may concern very small works or very large ones. Particular emphasis is placed on joint projects which will serve a number of municipalities, whether this be for water supply or sewage disposal.

2. Projects undertaken by the Commission are, in general, confined (a) to works for the supply, purification, and delivery of water through feeder mains to the contracting party's distribution system, or (b) to trunk sewers, treatment works, and sewer outfalls. It is only in the case of small communities that the Commission undertakes the construction of the local water distribution mains or the sewage collection system. In those instances it is felt that there is a definite advantage to have all the work done under one contract and under one management.

3. When the agreement has been approved by both parties, the Commission goes forward on the necessary plans and specifications. The policy of the Commission has been to appoint consulting engineers to do the design work and also to do field supervision during construction. Thus, the consulting engineer is an employee of the Commission rather than of the municipality. He engages the resident engineers and field staff to supervise construction. The Commission maintains a separate construction branch to deal with this work and to ensure that the project is carried out to its satisfaction.

4. All contracts for these projects are awarded by the Commission, and the complete program is under the direct responsibility of the Commission. Payments are made to the contractor as work progresses, also to the suppliers of equipment and to the consulting engineers. In this way, no payments are made by the contracting municipality until the works are in operation.

5. The agreement between a municipality and the Commission is based on the latter assuming responsibility for the operation and maintenance of the works during the lifetime of the debt. When the project is constructed, the responsibility passes from the construction division of the Commission to the operating division. The personnel for these operations are engaged by and paid for by the Commission. Where there are small works, not requiring the services of a full-time staff, arrangements may be made to employ on a part-time basis some of the local employees of the municipality or others.

6. The agreement between the municipality and the Commission contains a clause whereby at the termination of the debt the works may be returned to the municipality at the request of either party. Extensions or enlargements of the works may be made by the Commission at the request of the municipality and in this way, the debt retirement period may be extended for a longer period. Each of these extensions involves a new agreement between the Commission and the municipality, and the Commission would not have the right to extend the original works under the terms of the first agreement.

7. An important part of this entire program is the means for cooperation between the Commission and the municipalities served. Each municipality is asked to appoint a local advisory committee to work with the Commission and to deal with all aspects of the program. In this way there is local direction for such matters as appointment of employees, wages paid, and many other features of administration. This tends to relate the activity to local conditions rather than having one set of standards or requirements for the entire Province.

8. The Commission offers to each municipality extensive services in the operation of the works. There is the closest coordination of all technical matters in which the advice of the local engineering staff is combined with the specialized training of the Commission's personnel. In small municipalities where new works are being installed and where there has been little local experience on such matters the Commission advises on all aspects of the administration, including rate structures, bookkeeping, records, etc. In this way, each municipality receives full use of the Commission's laboratory facilities and its technical staff without cost to that municipality.

Financing Commission Projects

The financial arrangements for the projects constructed and operated by the Commission are an important part of the over-all program. Stringent money conditions including difficulty of obtaining loans, and current high interest rates have added to the burdens of municipalities in financing undertakings independently. Under the plan offered by the Commission, the municipality does not need to issue or sell any debentures or bonds. Money is advanced by the Commission, for which the credit of the Province is pledged. The debt is paid back over a long period, 30 years in most instances, but varies according to the wishes of the municipality. The interest amounts to the actual cost of money borrowed by the Province. This rate is normally lower than it is possible for the municipality to obtain on the open market. The indebtedness of the Commission can be met by the sale of its own bonds, which are guaranteed by

the Province, or it can borrow directly, as it has to date, from the Provincial Treasurer, thereby gaining the advantage of borrowing on a large scale.

A number of advantages can be found in this method of financing in addition to the more favorable interest rate. One is the flexibility of the agreement. The municipality makes no payment to the Commission until the work is put into operation. The debenture period may be made to suit local needs. Principal payments may be deferred at the outset and up to a period of five years after the work is completed. The interest rate will vary each year, and as the prevailing high interest rate is lowered, the municipality obtains this advantage of further saving.

In Ontario, all financial obligations to be incurred by municipalities come under the supervision of the Ontario Municipal Board. The Board thus determines whether the obligation is within the ability of the municipality to carry. This same requirement applies whether the municipality is doing the work itself, or whether the work is done under the Water Resources Commission. In the latter instance, the Commission deals directly with the Board for the municipality.

Where a number of municipalities or other parties are concerned with a single project, the agreement provides for allocation to each of these that part of the capital debt for which they will be responsible to the Commission. The cost of the water delivered or the sewage treated is based on this and the actual cost of operation. At present, the Commission is undertaking sewage projects in which a number of municipalities will be provided joint service including the trunk sewers and the treatment facilities.

The basis of all financial agreements with municipalities is that they shall pay to the Commission the actual cost of the debt and service rendered. The latter does not include the supervisory services of the Commission, but only those operators actually engaged on the project. No money grants are involved in these programs. The contracting municipality will pay quarterly to the Commission the estimated amount of capital and operating charges as well as a reserve fund for contingencies, repairs, and replacements. At the end of the year an adjustment is made with the actual costs for that period. These financial procedures relieve the municipality of all details involved in borrowing money for capital works.

Sanitary Supervision over Sewage Works

The other part of the Commission's program involving sanitary supervision over sewage plants as well as water utilities is similar to that which is normally carried out under a Provincial or State health department. All plans for water and sewage works installations, or extensions to existing works, require the approval of the Commission before construction is undertaken. In this way, the Commission is given wide powers to deal with the water resources of the Province, and has the right to regulate water use.

Major emphasis is placed on the control of stream pollution. If water resources are to be made available for the maximum use and public benefit, pollution control must be exercised rigidly. The Commission, under the legislation, is empowered to deal with the protection of all water supplies. Heavy penalties are provided for infringement of this. A departure from the usual public health provision against pollution is that under the Commission's program this is not to be confined to something which may only affect public health, but rather it is widened to include anything which may impair the quality of the receiving watercourse. A substantial portion of the activity of the Commission since its inception has been de-

voted to sewage and waste disposal and to the abatement of stream pollution.

Organization of the Commission

The Commission's program has been organized to give effect to these various outlined activities. The Commission, at present consisting of four members, decides on all matters of policy. The administration of these policies comes under a General Manager acting through six divisions or branches. These consist of Administration, Laboratories and Research, Construction, Plant Operations, Sanitary Engineering, and Water Resources. The staff has grown at a rapid rate, and now exceeds 150. A new laboratory is under construction to serve the needs of the Commission and to give service to all municipalities operating water and sewage works. Research programs will be emphasized in this laboratory, and there will be full cooperation with industry and with municipalities.

Progress

The program of the Commission is as yet in its early stages. The act of the Legislature came into effect only in April 1957. Since that time it is gratifying to note the number of projects which have been undertaken. To date, agreements have been made with 40 municipalities for works involving an estimated expenditure of approximately $25,000,000. Seven of these are already in operation and others are in various stages of development. In many other instances agreements are pending and preliminary engineering work is being done. These include both small and large works. Water will be pumped considerable distances to meet many supply requirements. Sources of water supply will be developed wherever they are considered most advantageous. Sewage treatment will be provided to suit the local needs, and trunk sewers will be constructed to treatment plant sites or to outlets. Municipal boundaries are not to be regarded as the basis for the treatment of sewage. Instead, this is considered as an area problem, so that regardless of the municipality in which the area is situated it may be combined with the adjacent area to advantage and for economy to all concerned.

The boundary waters between Ontario and the United States offer a challenge in the effective control of pollution. These waters with unsurpassed international value must possess high quality to serve their many functions. The International Joint Commission has made surveys and has maintained close contact with existing conditions. Enforcement of quality standards set by the International Joint Commission has been carried out on the Canadian side by the Ontario Water Resources Commission. This is a cooperative effort designed to reach the desired objective of good stream sanitation.

Good progress is being made on pollution abatement in the boundary waters. The Commission is participating in the building of municipal plants and is cooperating closely with industry in their waste treatment problems. Joint efforts can be most effective, and in the boundary waters there is every expectation that the desired results will be a reality in the near future.

Summary

A review of the program of the Ontario Water Resources Commission at this time emphasizes the significance of the original objective to facilitate the development of water supplies and sewage disposal for all municipalities whether they be inland or on large bodies of water. The Province has adopted a program of pollution abatement and the full protection of all watercourses in the Province. This pertains both to municipalities and industries. A great deal of effort is being devoted to sanitary surveys of all watercourses and all outfalls to

these streams. Special efforts are being directed to the control of outfalls in small municipalities as well as in large ones. In this way, it is hoped to be able to rid all streams of pollution. This is a further step in a program aimed at close cooperation between the Province and the municipalities. The results obtained to date have been most gratifying in spite of the heavy expenditures required for these works. It is not possible to predict with accuracy the length of time needed to deal with all sources of pollution now reaching the streams, but the work is proceeding at a rapid pace, and there has been real cooperation received from municipalities and from industry.

The degree of treatment of sewage and industrial waste is aimed at the protection required for the watercourse. This naturally will vary according to local conditions. The trend, however, is definitely toward more complete treatment and for raising the standard of stream sanitation throughout the Province. As the treatment works come into operation, rigid control will be exercised by the Commission to prevent the discharge of untreated or inadequately treated wastes to any stream. In this objective, it is felt that the population growth can go forward and industry can expand, while at the same time streams can be utilized fully for disposal of these effluents without undue impairment of their quality or their usefulness. Cooperation of all concerned, which is the basis of this program, cannot fail to achieve the desired results.

NUCLEAR WASTES COMMITTEE

Recognizing the increasing importance of the nuclear energy industry, the Federation Board of Control recently established the Nuclear Wastes Committee to deal with the specialized problems in this field. The Committee first reported to the 1958 Board of Control Meeting to outline its plans.

This committee is prepared to cooperate with the Program Committee in the formulation and presentation of a part of the technical program of future Federation meetings. The committee members will be available in the area of radioactive liquid wastes for general discussions, paper presentations, and leadership of workshops at Member Association meetings.

Periodic contributions to the Journal will include technical articles, progress reports, lists of available literature, and reviews of the status and application of federal, state, and local laws relating to radioactive wastes.

Chairman Jim Smith will welcome any comments and suggestions to assist in guiding the committee's efforts. Address correspondence to:

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THE TOXICITY OF SYNTHETIC DETERGENTS AND SOAPS TO FISH

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A major expansion in the use of syndets (synthetic detergents) for household washing purposes has occurred during the past decade. Introduced in the early thirties, syndets accounted for approximately 16 per cent of the total 1948 market for soaps and detergents. By 1956, approximately 70 per cent of the soap-detergent market consisted of syndets and production exceeded two and one-half billion pounds (1). It is estimated by McKinney (2) that by 1962, syndets will make up 80 per cent of this market and that production will have further increased to three and one-half billion pounds.

Some of the household syndets, unlike soaps, are not readily subject to biological oxidation or degradation, and thus pass through sewage treatment plants relatively unchanged. Surface waters receiving large proportions of sewage effluents or those subject to considerable reuse may build up appreciable syndet concentrations.

It has been reported that fairly low syndet concentrations may cause problems such as foaming, difficulties in coagulation and sedimentation, and tastes and odors in water treatment plants (3)(4). Russell (5) reported on frothing, and Fuhrman and Rice (6) discussed reduction in gas formation and BOD removal in sewage treatment plants. Investigations have been made and are in progress on the effects of syndets on water and sewage treatment processes. Water treatment problems such as foaming (7), effects on coagulation and sedimentation (8)(9), effects on filtration (10), and tastes and odors (11)(12) have received investigation. Gowdy (13) and Lynch and Sawyer (14) studied problems such as frothing, while Manganelli and Crosby (15) covered effects on microorganisms, and Rudolfs *et al.* (16) and Sawyer *et al.* (17) studied effects on reaeration and BOD removal in sewage treatment plants. Hammerton (18) investigated the persistence of surfactants (surface active agents) in natural waters. Past and current investigations have been summarized by McKinney (2), Coughlin (19), Moss (20), and American Water Works Association Task Groups (1)(21).

Little attention has been given by investigators in the United States concerning toxicity or other effects on fish and aquatic life in streams and lakes. Other than several studies of the effects on microorganisms and algal blooms, an investigation of the toxicity of various sodium sulfonates to a microcrustacean by Freeman (22), and a study of the toxicity of some complex phosphates to fish by Daugherty (23), little information on this subject can be found in current literature. It is known, however, that several investigations of the toxicity of syndets to fish have been made by the Washington and Wisconsin State Water Pollution Agencies, but results of these studies are not known to have been published.

While there have been no reports of major damage to fisheries in this country, the concentration of syndets

in sewage and surface waters is increasing. Concentrations of syndets in sewage from various cities have been reported to range from 4 to 45 ppm (21). On the basis of present syndet production, it is estimated that current sewage should contain an average of 10 ppm of surfactant with a concentration of biologically resistant ABS (alkyl benzene sulfonate) of 5 ppm (2). Future predictions indicate an average of 14 ppm surfactant in six years.

Several streams in Kansas have been reported by Culp and Stoltenburg (3) to contain from 1.9 to 6.6 ppm syndet. The concentration of syndet in the Wheeling, West Virginia, water supply, obtained from the Ohio River, was reported as high as 12 ppm with a maximum daily average of 4 ppm (4). However, the Ohio River at Cincinnati, reportedly contained about 0.1 ppm apparent ABS surfactant during a moderate flow period (19).

In some European countries, the possible effects of detergents on fish have received considerably more attention than in this country. Foaming and fish mortality have been observed there in streams below sewage treatment plants. In addition to studies on the effects of syndets on water and sewage treatment, investigations concerning their toxicity to fish have been made in Great Britain by Degens *et al.* (24), Roberts (25), the Water Pollution Research Board (26), and Herbert *et al.* (27), in Germany by Mann (28), in Belgium by Le Clerc and Devlaminck (29), and in Switzerland by Schmassman (30).

British investigators have reported the average concentration of anionic surfactant in sewage to range from 3 to 6 ppm (27). Much higher values, however, ranging upward to 20 ppm, have been reported for some sewage effluents by Roberts (25) and by Painter (31), with the values increasing from year to year. The concentration of detergent in British rivers has been reported to range from 0.2 to 4.9 ppm (27).

Bio-assays were made on some syndets and soaps commonly used as household washing products to determine their toxicity to fish and to evaluate properly their possible effects on aquatic life. Bio-assays were also made on major surfactants and builders normally contained in household syndets.

Bio-assay Methods

In the studies described in this paper, bio-assays were made, essentially by the method recommended by Doudoroff and his Subcommittee on Toxicity (32). The laboratory setup and equipment were similar to those described by Henderson and Tarzwell (33).

This method consists of preparing a series of concentrations of the test material in a selected dilution water, adding the test fish, and observing their reactions over a definite time period. From the observed fish mortality, a direct, comparative measure of toxicity is obtained.

In these experiments, two different dilution waters were used: a very soft water prepared in the laboratory by mixing 95 parts of distilled, demineralized water and 5 parts of a natural spring water, and a naturally hard limestone water obtained from springs. These waters were adjusted to the test temperature and aerated vigorously for about one hour to bring them into equilibrium with atmospheric gases before using. The average characteristics of the dilution waters at time of use are shown in Table I.

TABLE I.—Characteristics of Dilution Waters Used in Toxicity Experiments

Water	Dissolved Oxygen (ppm)	pH	Alkalinity (ppm)	Hardness (EDTA) (ppm)
Soft water	8.0	7.4	18	20
Hard water	8.0	8.2	360	400

The principal test fish used were fathead minnows (*Pimephales promelas*), ranging in length from 2 to 2½ in. and in weight from 1 to 1½ g. Bluegills (*Lepomis macrochirus*), approximately 2 in. long and weighing 1½ g, were used in a few experiments.

All bio-assays were conducted in a constant temperature room at 25°C. The tests were designed so that no aeration or oxygenation was needed. Absorption of atmospheric oxygen by the exposed water surface was adequate for fish requirements during the test period.

A logarithmic series of concentrations (e.g., 10, 5.6, 3.2, 1.8, and 1.0 ppm) of test material was prepared. Five fish were added to 10-l duplicate samples of each test solution in 5-gal wide-mouth glass bottles. Fish reactions were observed over a 96-hr period. Analyses for dissolved oxygen, pH, alkalinity, acidity, and hardness were made on each test concentration initially, and after fish mortality, or at the end of the test period.

From the observed fish mortality in different concentrations, 24-, 48-, and 96-hr median tolerance limit (TL_m) values were computed. These values were obtained by plotting per cent survival of fish against log concentration of test material and interpolating for the fifty per cent value.

Toxicity of Syndets and Soaps

Bio-assays were conducted on five packaged household syndets (Cheer, Tide, Dreft, Felso, and Vel) obtained from a retail grocery. The approximate surfactant and builder content of these products is shown in Table II. Small quantities of other materials such as sodium silicate and about five per cent moisture were present in these syndets.

The soap products used for bio-assays were packaged powders or flakes (Lux Flakes, Ivory Snow, and Fels Naptha) also obtained from a retail grocery. These were all relatively pure soaps but contained some moisture and small amounts of impurities. Bio-assays were also conducted on pure sodium stearate.

TABLE II.—Surfactant and Builder Content of Household Syndets

Syndet Sample	Composition (per cent)			
	Surfactant		Builder	
	Alkyl Benzene Sulfonate	Alkyl Sulfate	Sodium Tripoly-phosphate	Sodium Sulfate
SD-1	30	—	27	20
SD-2	31	—	57	—
SD-3	22	8	—	65
SD-4	18	—	47	25
SD-5	9	9	50	20

A summary of bio-assay results showing 24-, 48-, and 96-hr TL_m values for the various syndets and soaps to fathead minnows in soft and hard waters is shown in Table III. All values are reported in parts per million by weight (milligrams per liter) of the packaged product.

Syndets

The household syndets were all toxic to fish at moderate levels, and the different packaged products fell within a fairly narrow range of toxicity values. Ninety-six-hour TL_m values ranged from 41 to 85 ppm in soft water and from 15 to 87 ppm in hard water. Some variation in effect would be expected due to the different surfactant and builder contents of the several syndets (Table II). Four of the five syndets were more toxic in hard water with the average for the five products (96-hr TL_m—39 ppm) indicating a slightly higher toxicity in hard than in soft water (96-hr TL_m—61 ppm). This is in reasonable agreement with the work of Le Clerc and Devlaminck (29) and Schmassman (30) who have reported that the toxicity of syndets was not greatly affected by hardness in water.

Only minor increases in fish mortality occurred between the 24- and 96-hr periods. This probably would indi-

cate a fairly rapid reaction of fish to these materials with only a slight cumulative or chronic toxicity expected from longer exposure.

Dissolved oxygen apparently was not greatly affected even in the highest concentrations of syndets tested. The DO levels remained within limits (4 to 8 ppm) adequate to support fish during the 96-hr test period without any artificial addition of air or oxygen. It has been reported (26) that syndets reduce the rate of entry of oxygen into water. This effect was apparently not great enough to have any influence on these experiments.

The higher concentrations of four of the syndets caused a slight increase in pH (0.5 to 1 unit) in soft water but no change in hard water. Levels, however, remained well within limits (6.5 to 8.5) tolerated by fish. These syndets caused some increase in alkalinity and a decrease in hardness. The fifth syndet had no apparent effect on pH, alkalinity, or hardness, in either type of water.

Soaps

The toxicities of three packaged soaps (Table III) were quite similar, especially in soft water. The 96-hr TL_m values in soft water ranged from 29 to 42 ppm (average 34 ppm) and indicates that these materials are slightly more toxic than syndets. In hard water, however, the average TL_m value (1,470 ppm) indicates soaps to be about forty times less toxic in hard than in soft waters and from twenty to forty times less toxic than syndets. This probably is due to the fact that soaps form insoluble complexes or precipitates in hard waters which appar-

TABLE III.—Median Tolerance Limits of Syndets and Soaps to Fathead Minnows in Soft and Hard Waters

Product	Median Tolerance Limit (mg/l of packaged product)					
	Soft Water			Hard Water		
	24 Hr	48 Hr	96 Hr	24 Hr	48 Hr	96 Hr
(*a*) Household Syndets						
SD-1	46	44	41	20	16	15
SD-2	63	61	61	21	21	17
SD-3	64	62	61	28	28	28
SD-4	85	85	85	51	51	48
SD-5	59	59	59	100	90	87
Average	63	62	61	44	41	39
(*b*) Household Soaps						
S-1	32	29	29	1,100	920	920
S-2	43	41	32	1,800	1,700	1,700
S-3	42	42	42	1,800	1,800	1,800
Average	39	37	34	1,530	1,470	1,470
(*c*) Pure Compound						
Sodium stearate	100	100	100	>1,800	>1,800	>1,800

ently are non-toxic to fish. Thus, while the toxicity of household syndets is roughly comparable to soaps in soft waters, soaps are much less toxic in hard waters. The pure compound, sodium stearate, was somewhat less toxic than the packaged soap products.

As with syndets, fish mortality was only slightly increased between the 24- and 96-hr periods. Thus, soaps would not be expected to have a very great cumulative or chronic toxic effect on fish exposed for longer time periods.

The higher concentrations of soaps in hard waters caused some oxygen depletion in the test solutions. This would indicate some bio-oxidation during the 96-hr test period. Minimum dissolved oxygen levels (2 ppm) were not, however, believed to have caused any fish mortality or to have significantly affected test results. No air or oxygen was added artificially during the test period.

A pH rise of from 1 to 2 units was caused in the higher concentrations of soaps in both soft and hard waters. The maximum values (9.2 to 9.5) may have contributed to fish mortality in some of the highest test concentrations. The range of pH values, however, in concentrations near the 50 per cent fish mortality point were such (7.0 to 8.6) as to have little effect on TL_m values. Alkalinity levels were increased and hardness levels decreased by the addition of soaps to both kinds of dilution waters.

Toxicity of Surfactants and Builders

Common household syndets ordinarily contain from 18 to 40 per cent of surfactant with the remainder consisting of an inactive carrier or builder. In order to evaluate properly the toxicity of household syndets, bio-assays were conducted separately on some of the major surfactants and builders used in the preparation of the packaged products.

The major type of surfactant used in household syndets is the anionic alkyl benzene sulfonates. As the ABS compounds may vary in chemical composition, samples for bio-assay were obtained from four different manufacturers. The four different samples, containing from 40 to 100 per cent alkyl benzene sulfonate, were labeled as follows: (a) ABS-1, 100 per cent; (b) ABS-2, 85 per cent; (c) ABS-3, 60 per cent; and (d) ABS-4, 40 per cent. The inactive material in these products was mostly sodium sulfate.

Anionic alkyl sulfates sometimes may be incorporated in household syndets. Sodium lauryl sulfate (AS-1) was used to typify this type of surfactant.

A nonionic surfactant described as 100 per cent polyoxyethylene ester (PE-1) also was used for bio-assays.

The major builders used in household syndets are sodium tripolyphosphate and sodium sulfate. Bio-assays were made on these pure compounds to determine their possible contributions of toxicity.

A summary of bio-assay results showing 24-, 48-, and 96-hr TL_m values for surfactants and builders is shown in Table IV. All results are reported in mg/l of the manufactured product. The values are all on the basis of results obtained with fathead minnows, except for one experiment with bluegills noted in the table.

Surfactants

The results for the ABS compounds are not directly comparable, as they contain different amounts of surfactant. The 96-hr TL_m values ranging from 4.5 to 23 ppm in soft water and 3.5 to 12 ppm in hard water indicate that these materials are considerably more toxic than packaged syndets (Table III) and are somewhat more toxic in hard than in soft waters. ABS-1 was slightly less toxic to bluegills (96-hr TL_m, 5.6 ppm) than to fathead minnows (96-hr TL_m, 4.5 ppm).

The alkyl sulfate surfactant (AS-1, sodium lauryl sulfate) was of approximately the same toxicity as the pure

TABLE IV.—Median Tolerance Limits of Surfactants and Builders*

Product	Median Tolerance Limit (mg/l of manufactured product)					
	Soft Water			Hard Water		
	24 Hr	48 Hr	96 Hr	24 Hr	48 Hr	96 Hr
(a) Surfactants						
Alkyl benzene sulfonates:						
ABS-1	4.8	4.5	4.5	4.0	3.5	3.5
ABS-1†	8.2	7.5	5.6	—	—	—
ABS-2	4.5	4.2	4.2	4.4	4.4	4.4
ABS-3	15	15	15	8.5	8.5	8.5
ABS-4	23	23	23	12	12	12
Alkyl sulfate:						
AS-1	5.9	5.1	5.1	6.1	5.9	5.9
Polyoxyethylene ester:						
PE-1	42	37	37	56	42	38
(b) Builders						
Sodium tripolyphosphate	140	140	140	1,350	1,300	1,300
Sodium sulfate	13,000	11,000	9,000	14,000	13,500	13,500

* The test fish were fathead minnows except as noted.
† The test fish were bluegills in this experiment.

alkyl benzene sulfonate (ABS-1). This material, in contrast to ABS, was slightly less toxic in hard than in soft water.

The nonionic polyoxyethylene ester surfactant (PE-1) was equally toxic in soft and hard waters but was considerably less toxic (96-hr TL_m, 37 ppm) than either of the anionic surfactants.

There was only a slight increase in fish mortality between 24 and 96 hr indicating little accumulative or chronic toxicity from any of the surfactants.

Characteristics of the dilution waters (DO, pH, alkalinity, and hardness) were not altered to any appreciable degree by any of the surfactants.

Builders

As compared to surfactants, builders were relatively non-toxic to fish. Sodium tripolyphosphate was, however, considerably more toxic than sodium sulfate. The toxicity of sodium tripolyphosphate was about ten times greater in soft (96-hr TL_m, 140 ppm) than in hard water (96-hr TL_m, 1,300 ppm).

While dissolved oxygen content of the test solutions was not affected by even the highest concentrations of sodium tripolyphosphate, other characteristics (pH, alkalinity, and hardness) were affected appreciably. In higher concentrations, pH levels were raised to 9 or above and may have contributed to fish mortality. Alkalinity levels were increased and hardness values decreased. In concentrations of 100 ppm in soft water and 1,800 ppm in hard water, hardness values were reduced to zero.

The 96-hr TL_m values for sodium sulfate (9,000 ppm in soft water; 13,000 ppm in hard water) were such that this compound generally would

be considered non-toxic to fish. In accordance with Ellis (34), almost any salt in this concentration would cause mortality of fresh water fish due to osmotic effect. No effects on dissolved oxygen, pH, alkalinity, or hardness were apparent in even maximum concentrations of this compound.

The effect of some of the syndets on pH, alkalinity, and hardness, as previously mentioned, apparently was caused by the sodium tripolyphosphate builder.

Significance of Bio-assay Data

The comparative bio-assay results show that while syndets and soaps are of approximately equal toxicity in extremely soft water, detergents are about forty times more toxic in very hard water. As most natural waters are moderately hard, syndets generally would be of more significance than soaps from the standpoint of toxicity to aquatic life. Also, the fact that soaps are readily subject to biological decomposition while some syndets are highly resistant would make it more likely that syndets would cause a fish toxicity problem than soaps, even on the present consumption basis. In the future, expansion of the population with increased use of syndets and the further reuse of natural waters may intensify the toxicity problem.

Other possible effects on aquatic life such as oxygen depletion and formation of precipitates or sludges may be less important with syndets than with soaps. While it has been reported that syndets may reduce the rate of solution of atmospheric oxygen into water, in these bio-assays the depletion of oxygen was greater in test solutions of soaps, probably due to more rapid bio-oxidation. Organic content of syndets is less than that of soaps, and BOD values for sewage have reportedly decreased with increased use of syndets (6). Precipitates in hard water are much greater with soaps than with syndets.

Phosphates in syndets may increase biological productivity of natural waters and thus provide for more rapid growth and larger fish populations, provided toxicity or other adverse effects are not encountered. However, the increased productivity may lead to other problems such as plankton blooms which may cause tastes and odors in water and filtration difficulties in water treatment plants.

Bio-assays of syndet components (Table IV) show that the surfactant is the major toxicant. Little if any toxicity is contributed by the builder. The computed comparative toxicity values of surfactants and syndets, based on actual surfactant content, are shown in Table V. There were some differences in the toxicity of the different ABS compounds when compared

TABLE V.—Comparative Toxicity of Surfactants and Synthetic Detergents to Fathead Minnows when Based on Surfactant Content

Product	Surfactant (per cent)	96-Hr Median Tolerance Limit (mg/l of surfactant on 100 per cent basis)	
		Soft Water	Hard Water
(*a*) Surfactants			
Alkyl benzene sulfonates:			
ABS-1	100	4.5	3.5
ABS-2	85	3.6	3.7
ABS-3	60	9.0	5.1
ABS-4	40	9.2	4.8
Average	—	6.6	4.3
Alkyl sulfate:			
AS-1	100	5.1	5.9
(*b*) Synthetic Detergents			
SD-1	30	12.3	4.5
SD-2	31	19.0	5.3
SD-3	30	18.3	8.4
SD-4	18	15.3	8.6
SD-5	18	10.6	15.6
Average	—	15.1	8.5

on this basis. Ninety-six-hour TL_m values ranged from 3.6 to 9.2 ppm with an average of 6.6 ppm in soft water and from 3.5 to 5.1 ppm with an average of 4.3 ppm in hard water. This would indicate some difference in the toxicity of the alkyl benzene sulfonates or an antagonistic effect (decrease in toxicity) caused by the sodium sulfate contained in some of these commercial surfactants.

The alkyl sulfate surfactant had nearly the same toxicity (96-hr TL_m, 5.1 ppm in soft water and 5.9 ppm in hard water) as the average for the alkyl benzene sulfonates. This surfactant, however, would be less likely to produce a toxicity problem in natural waters as it is much more readily subject to biological decomposition.

On the basis of actual surfactant content, the syndets were somewhat less toxic than surfactants. Ninety-six-hour TL_m values for syndets ranged from 10.6 to 19 ppm with an average of 15.1 ppm in soft water and from 4.5 to 15.6 with an average of 8.5 ppm in hard water. Although an effort was made to use comparable products, the ABS surfactants may have been somewhat different from those in the household syndets. The builders may have had a slight antagonistic effect which caused some reduction in toxicity.

The TL_m values reported in this paper are concentrations that produce 50 per cent mortality of moderately sensitive warm water fish in a relatively short time period under the specified experimental conditions. While these data cover a reasonable range of water quality conditions which may be expected in natural waters, other conditions may be encountered or other chemicals may be present which may have a synergistic or antagonistic effect and thus change the toxicity picture. Other species of fish, different stages in their life history, and major fish food organisms may be more or less sensitive than the test fish. These factors must be considered in estimating a safe surfactant concentration for natural waters.

Unfortunately, few investigations have been made and there is a paucity of data available in this country on the effect of syndets and surfactants on different aquatic organisms. Unpublished data from the Wisconsin State Board of Health has shown 48-hr TL_m values for several laundry syndets to range from 15 to 45 ppm, when using yellow perch and bluegills as the test fish. Unpublished data from the State of Washington Pollution Control Commission have shown critical concentrations of anionic surfactants for silver salmon to range from 5.6 to 10 ppm. Bio-assays conducted by Freeman (22) have shown 50 per cent mortality of *Daphnia magna* on exposure for 100 hr to various sodium sulfonates in concentrations ranging from 12 to 3,380 ppm. Sodium benzene sulfonate was among the least toxic of 10 different compounds and as the ring structure became more complex, the sodium sulfonate was more toxic. Daugherty (23) conducted experiments which indicated the minimum lethal dose of sodium polyphosphate to fish ranged from 500 to 1,000 ppm. This compound was not as toxic as the sulfates or sulfonates of fatty acids.

The syndet toxicity problem has received considerably more attention in European countries. Schmassman (30) reported that 10 ppm of a Swiss syndet affected the respiration of fish and that 20 ppm of a German syndet killed fish in 12 hr. The toxicity of syndets was unaffected by hardness in water. Le Clerc and Devlaminck (29) reported minimum lethal concentrations of syndets to fish as ranging from 2 to 20 ppm in distilled and hard waters, with the type of water having little effect. Minimum lethal concentrations for sodium lauryl sulfate and sodium dodecyl benzene sulfonate were from 6 to 7 ppm of active product. Toxic concentrations for sodium stearate were from

10 to 12 ppm in distilled water and 250 to 300 ppm in hard water.

Degens *et al.* (24) reported that concentrations of anionic surfactants as low as 5 ppm were toxic to daphnia, stickelbacks, roach, and carp. Higher concentrations (9 to 36 ppm) could be tolerated if fish were properly acclimated by a gradual buildup from 3 ppm of surfactant. Roberts (25) reported that concentrations of from 2.5 to 10 ppm of surfactant affected rainbow trout and fresh water shrimp (*Gammarus pulex*) and that concentrations of from 10 to 20 ppm had an effect on aquatic plants. Surfactant in treated sewage apparently had less effect than similar concentrations from the manufactured material. Herbert *et al.* (27) reported that 3 ppm of surfactant in a mixture of seven household syndets caused a 50 per cent mortality of rainbow trout in 12 days. The residues remaining in treated sewage effluents are less toxic to fish, and concentrations in British rivers containing fish are usually less than 3 ppm surfactant.

Mann (28) reported syndets as toxic to fish and fish food organisms at concentrations from 10 to 25 ppm. Among fish food organisms, turbificids were most resistant and chironomids most sensitive. As concentrations of up to 10.7 ppm have been found in sewage, the possible effects on aquatic life must be considered.

From the bio-assay data reported in this paper, along with other available information, it appears that concentrations of ABS surfactants exceeding 3 ppm may be expected to have a serious effect on aquatic life in natural waters. Lower concentrations may have an effect on more sensitive aquatic forms. More research information, both laboratory and field, is needed before more accurate safe concentrations can be estimated.

There is very little information available on present ABS concentrations in natural waters of fisheries or recreational importance. Reported concentrations of syndets and surfactants in sewage and some natural waters are shown in Table VI. On the basis of the reported concentrations in sewage, surfactants would not be expected to be at levels which would seriously affect aquatic life in the larger streams and lakes. However, in some of the smaller natural waters containing larger amounts of sewage effluents or those subject to considerable reuse some toxicity problems may be encountered. The increasing use of syndets and reuse of waters in the future may intensify the problem.

Summary and Conclusions

Synthetic detergents are rapidly replacing soaps as household washing products. While soaps have not created major fish toxicity problems in the past, it is not known what effect increased use of syndets may have on aquatic life in surface waters. Fairly low concentrations of syndets have reportedly affected some water uses, and some effect on fish has been reported in European countries.

The alkyl benzene sulfonate surfactants are resistant to biological degradation and thus are not readily decomposed by sewage treatment or natural purification processes. In heavily populated areas where streams contain large amounts of sewage or in areas of considerable water reuse, fairly high surfactant concentrations may be built up.

Bio-assays have shown that while syndets and soaps are of nearly equal toxicity to fish in soft water, syndets are approximately 40 times as toxic as soap in hard water. As most surface waters are moderately hard, syndets would be expected to be of greater significance from the toxicity standpoint.

Alkyl benzene sulfonates are highly toxic to fish and are mainly responsible for the toxic properties of household syndets. The builders contribute little,

TABLE VI.—Reported Surfactant or Syndet Concentrations in Sewage and Natural Waters

Source	Location	Surfactant or Syndet Concentration (ppm)	Reported as	Reference No.
Sewage	Ottawa, Kans.	39–44	Syndet	3
Sewage	9 cities in Kans.	4.1–34	Syndet	3
Sewage	Aurora, Ill.	45	Est. syndet	35
Sewage	Indianapolis, Ind.	42	Est. syndet	36
Sewage	U. S. average	10	Est. surfactant	2
Sewage	Benton Harbor, Mich.	8	Syndet	5
Water supply (Ohio River)	Wheeling, W. Va.	4–12	Syndet	4
Marais des Cygnes River	Kansas	3.9–6.6	Syndet	3
Neosha River	Kansas	1.0–1.9	Syndet	3
Creek	Kansas	11	Syndet	3
Ohio River	Ohio	0.1	ABS surfactant	19
Sewage	Great Britain	17–31	Surfactant	25
Sewage	Great Britain	3.6	Surfactant	27
Sewage	Great Britain	6–16	Surfactant	37
Sewage	Great Britain	6.2–26.1	Surfactant	26
Sewage	Germany	10.7	Surfactant	28
Rivers	Great Britain	0.2–4.9	Syndet	27

if any, toxicity. Ninety-six-hour TL_m values to fathead minnows averaged 6.6 ppm (range 3.6 to 9.2 ppm) in soft water and 4.3 (range 3.5 to 5.1 ppm) in hard water for four ABS compounds frequently used in household syndets. The toxicity was apparently somewhat decreased in the presence of builders.

Sodium lauryl sulfate, while as toxic to fish as ABS surfactants, is not as resistant to biological degradation. Thus, lower concentrations would be expected in natural waters. A polyoxyethylene ester type surfactant was considerably less toxic than the others.

None of the surfactants tested appeared to affect water quality characteristics such as dissolved oxygen, pH, alkalinity, and hardness. Some of the syndets and the sodium tripolyphosphate builder, however, have some effect on pH, alkalinity, and hardness.

A concentration of ABS surfactants as low as 3.5 ppm caused 50 per cent mortality of moderately sensitive fishes in a relatively short time. The accumulative or chronic toxic effect apparently was not great. Such concentrations, however, would be expected to have a serious effect on fish populations in natural waters. Limited information is available as to the effect of surfactants on other fishes and aquatic organisms or on natural factors which may tend to reduce toxicity. On the basis of these experiments and available information, concentrations of ABS exceeding 1 or 2 ppm may be expected to have some effect on the more sensitive fishes and other aquatic organisms in natural waters.

It is not known just what ABS concentrations have been reached in waters of recreational importance. Concentrations in sewage effluents exceeding 12 ppm ABS have been reported. While syndets are not at present considered of major concern from the standpoint of toxicity to aquatic life, increasing concentrations in surface waters may be expected in the future and some toxicity problems may occur.

Further investigation of the ABS content of natural waters, and field studies of aquatic populations in waters containing significant ABS concentrations are needed in order to evaluate possible future effects.

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MEETINGS OF INTEREST

1959

Mar. 16–20 **National Association of Corrosion Engineers,** Sherman Hotel, Chicago, Ill.

Mar. 17–18 **Air and Water Pollution Abatement Conference,** Netherlands Hilton Hotel, Cincinnati, Ohio. Manufacturing Chemists Association, Inc., 1625 Eye St., N. W., Washington, D. C.

Mar. 18–20 **Twenty-second Annual Short Course for Superintendents and Operators of Water and Sewerage Systems,** Louisiana State University, Baton Rouge, La. Fred H. Fenn, Dean, College of Engineering, Louisiana State University, Baton Rouge, La.

Apr. 2–3 **Eighth Southern Municipal and Industrial Waste Conference,** University of North Carolina, Chapel Hill, N. C. Dr. Daniel A. Okun, Dept. of Sanitary Engineering, School of Public Health, University of North Carolina, Chapel Hill, N. C.

Apr. 2–3 **Ninth Pacific Northwest Industrial Waste Conference,** University of Washington, Seattle, Wash. Professor Robert O. Sylvester, Dept. of Civil Engineering, University of Washington, Seattle 5, Wash.

Apr. 5–10 **American Chemical Society,** 135th National Meeting, Boston, Mass. R. M. Warren, American Chemical Society, 1155 16th St., N. W., Washington 6, D. C.

May 4–8 **American Society of Civil Engineers,** Hotel Cleveland, Cleveland, Ohio. W. H. Wisely, Executive Secretary, 33 West 39th St., New York 18, N. Y.

May 5–7 **Fourteenth Industrial Waste Conference,** Purdue University, Lafayette, Ind. Professor Don E. Bloodgood, Purdue University, Lafayette, Ind.

May 13–15 **National Rivers and Harbors Congress,** Mayflower Hotel, Washington, D. C. William H. Webb, Executive Vice-President, 1028 Connecticut Ave., N. W., Washington 6, D. C.

THE OPERATOR'S CORNER

SEWER MAINTENANCE—PANEL DISCUSSION *

I. RECORDS AND PERMITS

By Grant M. Olewiler

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Maps

To answer the primary question of "Where are the sewers," there should be available a street map of the municipality showing the location of the sewers, major drainage areas, pumping stations, and treatment facilities. The map should be of a size convenient for use in the field.

The next need is for a master map of the sewage collection system showing, to scale, the street system, the location, size, and grade of the sewers, the direction of flow, and the location of manholes. While the scale used should be large enough to show all data clearly, it should be small enough to allow sizeable areas to be seen without frequent turning to other sheets. Lower Merion Township uses a scale of 1 in. equals 400 ft to produce a three-section wall-mounted map about 8 ft long by 6 ft wide.

After real estate registry plans were prepared, all streets and recorded deeds were plotted using a scale of 1 in. equals 100 ft, and the entire set of plates was bound as an atlas. An ownership-identification number is given to each property. House numbers for each building as well as lot dimensions are shown.

The sewer system was plotted on the plates, together with the sewer connection permit number for each building, a colored tick indicating properties billed for sewer rental, the index number for the more detailed sewer record sheets, and the number of the deed of dedication for sewers that run across private property.

Detailed sewer record sheets, at a scale of 1 in. equals 40 ft, show by scale and dimensions the location of the sewers, the distances between manholes, the grade and depth of the sewers, and the stubs and laterals left for connection of abutting buildings. Data for these sheets are obtained from the inspectors' sketches made during the sewer construction and from location and elevation data collected after the roads were constructed or the properties graded. Experience has shown that original profiles are changed considerably by subsequent grading. Dates of surveys shown on the record sheets also give warning of depth changes in this connection.

Since sewer record sheets are in plan only, they are far less bulky than the original plans and profiles and

* In part from the transcript, 31st Annual Meeting, Federation of Sewage and Industrial Wastes Assns.; Detroit, Mich.; Oct. 6–9, 1958. The panel leader was Sydney A. Preen, Superintendent, Sewer Maintenance, Long Beach, Calif.

eliminate constant scaling to obtain depths. The original plans should be filed and indexed as a reference.

Extensions

Sewer extensions may be built under ordinance, whereby the municipality does the work either by contract or with its own forces and assesses all or part of the cost on the abutting owners. Extensions also may be built under permission granted to owners who are developing areas. When the latter procedure is used the plans and conditions must be approved by the municipality. In addition, the completed work must be dedicated as part of the public sewer system.

In either case strict compliance with the plans and specifications is essential. Records reported by the inspectors and data from later surveys are entered on the sewer system plans and sewer record sheets.

Sewer Connections

Records relative to the connection of all buildings are coordinated by the requirement that a formal application be filed by the owner of the property. Rules and regulations for making connections are printed on the application form. These applications are serially numbered and this number is used for all records.

The data from the application form are entered in a sewer connection record book and three colored cards are prepared. A red card is used for the lateral connection between the sewer and the side of the road; a blue card for the house connection between the side of the road and the building; and a white card for the count of plumbing fixtures in the building and the date of occupancy. The information from the white card is used to establish the sewer rental.

After the connection is inspected the data and a sketch showing the location of the connection are placed on the proper card. This card is returned to the office for filing and entry in the record book.

Since the billing for sewer rental does not start until the building is occupied, an inspection is made monthly of the properties for which white cards have not been entered and filed. If occupied, the date is noted, the fixture count is entered on the card, and the billing form is prepared. The billing rate remains constant until the fixture count is changed by additions or removals.

All plumbing work within a building must be done under approved plans filed with the plumbing inspector who reports any changes in fixtures by referring to the sewer bureau his final inspection card on which is entered the count of fixtures. Variances noted at the time of the occupancy inspection help to control illegal work on the plumbing system.

Periodic recounts of fixtures in all buildings at intervals of about ten years reveal illegal uses of the sewer, keep the sewer rental billing correct, and enable the plumbing inspector to check on work done without his knowledge.

All records of connections and plumbing work are extremely vital when trouble is encountered in the lines or when alterations are planned. The constant change in ownership of properties may leave the current owner without knowledge of buried lines. Since the municipality is the only continuing agency with a contact, it is essential that its records be preserved.

Maintenance Records

Sewers

Collection systems that are not cleaned at least once every five years may benefit from an annual inspection and flushing. This maintenance procedure warns of potential dangers and flushes small deposits which, if allowed to remain, build up over a few years to a point where a stoppage may occur.

The inspection and flushing work should be scheduled so that branch sewers are serviced first, followed by servicing of the mains, and then the interceptors. While inspecting the manholes the appearance of the flow and the condition of the manhole channels and walls should be noted and any defect recorded. The progress of the flushing water should be observed and an appropriate note made for any section in which the sewage does not attain the expected velocity.

After completion of the inspection and flushing, necessary cleaning and repair work noted on the daily report should be scheduled.

Since this cleaning will cover only a small portion of the system, any remaining time of the repair force should be devoted to a progressive cleaning of the entire system, even though it takes a number of years to complete. The progress of this work can be plotted on the master plan using a different color for each year.

Complaints of defects in the system, stoppages, noisy manholes, settlement of trenches or paving must be corrected promptly. A trouble book or log, in which entries are made of the time of call, foreman assigned, time dispatched, nature of trouble, and work done, forms a valuable record.

Pumping Stations

Maintenance records at pumping stations may be divided into three categories: (a) equipment, (b) power and water, and (c) structures.

Under equipment, work record cards giving the date, work done, parts numbers, and sizes and material used for each repair job should be put in a glassine folder and placed in a prominent position near each piece of equipment.

Monthly records of electrical charges should be studied as each bill is received. Each of the items upon which the bill is based should be considered separately, i.e., power demand, power consumption, and power factor. Studies of operational procedures may reduce the demand. Poor efficiency in the pumps because of wear of the impellers and heads may increase the power consumption. Installation of capacitors may eliminate penalties for a low power factor. Scrutiny of water bills may reveal excessive water use.

Work schedules for maintenance of each station should be prepared and posted. These schedules should show how often each maintenance task must be done. With any maintenance program satisfactory results can be expected only when the superintendent sees that the schedules are followed.

II. PUBLIC RELATIONS AND SAFETY

By M. B. Nixon

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An impression is made — good, bad or indifferent — on every person one comes in contact with. This simple fact means that the lack of a public relations program is a bad public relations program.

In sewer maintenance work a good public relations program is doubly important because a person who is having trouble with his sewer or has a flooded basement is not apt to be in the best of humor.

Sometimes the only contact a citizen has with the sewer department is through the foreman or a member of a sewer maintenance crew and by this contact he will judge the whole department. The foreman should be trained to deal with the public and every member of the crew should be instructed

to be courteous. Frequently, when a sewer maintenance job is going on, passers-by will inquire about the work. These passers-by may be the idly curious or they may be influential citizens showing an interest in city affairs. Whatever their purpose they are entitled to polite treatment and answers to their questions. A short answer will make a bad impression while a courteous, intelligent reply will create good will.

Personal Contacts

Every effort should be made to follow-up complaints. Normally, this can be done by a phone call in a few minutes. A follow-up of this sort not only promotes efficiency but creates good will and an understanding of the problems facing the sewer department.

In dealing with the public it is best not to get drawn into an argument. It is equally important to avoid making excuses or alibis. On the other hand, employees should be very careful not to commit themselves in regard to responsibility in the case of damage to property and should make no statements which could be construed as admitting liability on the part of the city. Such questions should be politely referred to the city office that handles claims against the city.

Patience and tact can be used to overcome many unpleasant situations. For example, some years ago the writer was assigned the task of securing easements from property owners for an outfall sewer in a semi-rural area. On being contacted one of the property owners immediately started a harangue on some unpleasant relations his father and grandfather had had with the city. Although thinking it would be a waste of time, the writer decided to hear him out and while doing so noticed that his house was furnished with many fine pieces of antique furniture. In order to leave as politely as possible the man was complimented on his home. A very pleasant conversation followed and the subject of the writer's visit was not brought up again until the property owner began asking questions about the proposed sewer. Amazingly, it was only a few minutes before the easement was signed. Arguing with the owner before he got his grievances off his chest would certainly have delayed construction of the sewer and could have resulted in the necessity of resorting to condemnation proceedings.

Publicity

The adage "no news is good news" should not be followed. There is no place for the theory that if you can "keep out of jail and out of the newspapers" you will be doing all right.

One of the most important phases of public relations is publicity. Enlist the aid of the newspapers and radio stations. Get acquainted with the newspaper men, especially the reporter assigned to cover city news. His job is to get the news and if you have any news of interest he is glad to get it. Take him around and show him what you are doing and get him to write a feature article on the work of your department. Newspapers frequently carry articles of this kind on various functions of the city.

Don't be afraid of unfavorable publicity. Sometimes there are failures or accidents that may cause unfavorable publicity, but it is better to let the facts be known because well-informed reporting is less likely to be as unfavorable as uninformed reporting.

So-called "unfavorable" publicity can sometimes be used to advantage if handled right. A feature article with pictures of the condition of some of the older trunk sewers in Atlanta helped get a bond allocation of a million dollars to rebuild these sewers.

Safety

From public relations to safety practices is an easy transition for safety in many ways is a part of public re-

lations. Usually, safety is thought of more in terms of protection of personnel and property than in protection of the public. Certainly, no one can be too safety minded as far as department personnel are concerned. Every precaution should be taken to protect them from the hazards of noxious gases, lack of oxygen, infections, physical injuries, and the hazards of traffic. There is much good literature on this subject and the FSIWA Manual of Practice No. 1 is especially recommended.

For the protection of the public and the workmen, warning signs should be placed at least 250 ft in each direction from the point where work is in progress. Equipment and trucks should have striped markings so they can be seen easily and any open excavation or manhole should have suitable barricades. At night, open excavations and equipment should be well lighted. Traffic warning signs should also be lighted.

Special care should be taken to keep the public, especially children, away from open ditches, open manholes, and machinery in operation. These are what the lawyers call "attractive nuisances" and if there is negligence in keeping them away, the city could be held liable for injuries.

Where necessary, a policeman should be assigned to direct traffic around obstructions and keep on-lookers at a safe distance.

The public should be advised when streets are to be closed or obstructed. This can be done through newspapers and radio stations. Some radio stations broadcast information on streets that are obstructed by construction or accidents during peak traffic hours in order that the motoring public may avoid traffic delays.

Conclusion

There is a definite need in the sewer maintenance field for better public relations and safety practices, and these subjects should have a high place on any in-service training program.

A good public relations program and a well-planned safety program will certainly make for fewer headaches for the sewer maintenance man.

Floor Discussion

Sidney Preen, Superintendent, Sewer Maintenance, Long Beach, Calif.:—I don't know how many of you gentlemen have any service training in your organizations at this time, but believe me, service training not only teaches our men how to take care of themselves, but how to work efficiently on the job.

In Long Beach, service training is held about once a month. The fire department has cooperated by teaching our men first aid and techniques relating to suffocation and anything else that they should know pertaining to our work. I wish to stress also that a training service program has a great deal of value and that it ties in very closely to public relations.

From the Floor:—I would like to ask what should be included in the list of safety equipment for the sewer maintenance crews?

Mr. Preen:—The thing that we stress is a safety belt, and believe me, the first time I catch anyone without a belt I am going to tell him, "If you don't give a darn about yourself, take care of your family. You have them to take care of. You have an obligation." Sewers are killers. We, in the sewer department, don't have a pistol nor a club nor anything else to protect ourselves. Sewers are the unseen enemy, most people are not aware of that. It is not the new man who gets hurt. It's the old-timer. He gets reckless and careless. I have lost two men. They

disobeyed orders and lost their lives. It was a terrible thing. Please, please gentlemen, insist on your men wearing life belts.

Ronald A. Kronewitter, Superintendent, Sewage Treatment Plant, Mishawaka, Ind.:—You mentioned a life belt. In your experience with life belts, what size rope do you use, how many men do you have above the ground, and have you pulled anybody out?

Mr. Preen:—We use a ¾-in. cotton life rope. The life rope is not spliced on the harness. It is fastened with a safety snap.

As to the number of men on top, we use three men in our cleaning crews and sometimes there are only two men on top. But when we work in an isolated area we use another man on the crew. We have pulled men out of sewers.

Mr. Kronewitter:—We use the same size life line and the same snap. Another piece of equipment that we found very helpful in chambers where there are two openings is a fireman's smoke ejector. We found that when the smoke ejector is placed over one manhole we can draw the air out of the chamber. It is very, very good.

We also use the ejector when we are working on a big sewer line. We put the smoke ejector on the upstream manhole. This puts a steady stream of fresh air in the sewer.

Mr. Preen:—I take it that the reason you use the smoke ejector is that you are afraid of poisonous and explosive gases. Is that right?

Mr. Kronewitter:—Not explosive gases but toxic gases. We check for explosive gases with an explosion meter.

Mr. Preen:—Do you get enough exchange of air with the smoke ejector?

Mr. Kronewitter:—Yes, we get a wonderful exchange.

Mr. Preen:—In larger sewers, we use a large fan and we get a good draft that way. Of course, we test for explosive gases before using the fan.

III. SEWER REPAIRS

By John L. Klamm

Superintendent, Sewer Maintenance, Kansas City, Mo.

Experience with sewer repairs in Kansas City leads to only one conclusion—each repair job is different. Factors affecting the repair such as the depth of the sewer, size, quantity of flow, surface structures, traffic, ground conditions, type of soil, and weather are never the same. Each time repairs are made it is reasonably certain that new approaches and procedures will be required.

Essentially, when a break or stoppage occurs about the only thing that is known is the depth to which the excavation must be made. In Kansas City this depth might be anywhere from 6 to 66 ft. At some locations there is plenty of room to use heavy equipment and in others the work must be confined to hand labor. Not too long ago there was a 65 ft excavation and there wasn't a piece of heavy equipment on the job.

While all of the above seems to suggest that most repair jobs are next to impossible, such is not the case. Actually, with well-trained personnel who know how to use equipment, most jobs can be completed without too much difficulty and in a short time.

In performing the pipe repair it should be remembered that work should be done in a fashion that will leave the pipe in as good a condition as a new, well-constructed line. Unfortunately, when working under wet conditions it

is not always possible to make a good joint.

Perhaps the biggest problem in Kansas City is not knowing the true condition of all of the system. Only the establishment of a comprehensive inspection and preventive maintenance program, which is fast being approached, will get to the bottom of most sewer problems.

Floor Discussion

From the Floor:—I would like to ask Mr. Klamm how much of the heavy equipment the city actually owns, how much they rent, and how much work they accomplish through private contractors using this equipment? Now, by heavy equipment, I mean such things as cranes, clam shells, and particularly pile-driving equipment.

Mr. Klamm:—The pile-driving equipment we do not own, but whether we should or not is a question. Just a short time ago we were in a hole where we had to drive sheet piling. Within forty-five minutes a contractor looked at the job and two hours later he was on the job with a crane and pile driver.

The equipment of the sewer division consists of: sixteen moving vehicles of all types, one backhoe, five compressors, two bucket machines, one large reel machine, and two small reel machines.

From the Floor:—The other question I would like to ask concerns sewer failures. We have every year a considerable number of joint failures, usually occurring in alleys.

Do you have many joint failures and do you consider the failure at the joint to be the responsibility of the city or is it the responsibility of the property owner?

Mr. Klamm:—I can say that we do have a lot of them, but not, necessarily, all in alleys. We experience approximately, I would say, 300 failures a year in our 1,000 to 1,100 miles of combination sewers.

At the present moment, we are trying to determine how far the City of Kansas City should maintain a private line. I have contended that if a tap joint was made at the time the line was installed, that tap joint, as well as the entire private line, should be the responsibility of the property owner. Should it have been connected to a "Y" or "T," naturally, that "Y" or "T" should be considered as part of the main.

We find that where joint failures occur a "Y" is usually involved, but slippage or, perhaps, a break in the house service line is also involved.

We find that these breaks, because of their depth, will cost from $400 to $1,100 to repair.

From the Floor:—Gentlemen, maybe you have read a paper a while ago by John Hood of Ridgewood, N. J. They had quite a bit of trouble on breaks caused by tree roots.

The village then took it upon itself to go among the home owners and supply copper sulfate. Once or twice a year they dropped some copper sulfate in the toilets, and they had quite a large reduction in breaks during the following year.

George E. Fieldhouse, Chief Engineer, Atlantic City Sewage Co., Atlantic City, N. J.:—In connection with wet joints we use a mixture of white pine tar and cement. The joint is made up in the wet, so to speak. The pine tar is heated into a bread dough consistency. The exact proportions, unfortunately, I don't recall.

Recently, I had the opportunity of examining some joints made 40 years ago and they were in excellent condition. The outside, except for an inch or so, was soft with sort of a rust-like consistency, but the inside of the joint was hard and firm and made a real good joint.

Mr. Klamm:—Did that joint have a good bond with the sewer pipe itself?

Mr. Fieldhouse:—Definitely, yes. The joint, of course, is held in place firmly with jute.

From the Floor:—My question concerns communities where sewers are placed in easements along the rear lot line. Of course, there are no alleys or rights-of-way. The question is—should the utilities be located in the easement or in the right-of-way, and if they are in the right-of-way, should they be located in the center of the right-of-way or on the right or left?

Mr. Klamm:—It is our duty to accept the sewer lines as they are constructed and maintain them. In our city we find the gas lines on one side of the street; we find the water mains on the other. It is much easier for us if the sewer line goes down the middle of the street. Yet, we have to contend more with gas and water services if it does go down the middle of the street.

Mr. Preen:—I want to answer that question. On easements, we find that our costs in cleaning and maintaining the sewers are running two or three times as much as it does when the sewers are in the streets.

I hope we have some designing engineers here, and, gentlemen, may I ask of you—please, when you design a sewer, put it out in the street where we can work on it. I am not going to quibble about whether it's in the center of the street. We have no objection to sewers being laid on curves. There is no reason why a sewer line can't follow the rest of the utilities around.

From the Floor:—What do you do about claims for damage caused by stoppages in the city's sewers? In our case we have many flooded basements caused by stoppages but our claims, I will say, are few. They are usually settled out of court. I know only of three or four that ever actually went to court.

I believe that most of the claims are filed because the people are simply upset to find water backing up in their basements. If it does back up and you are able to get it out in a hurry, they are usually satisfied with a showing of good service.

Following that line of thought, we have each repair truck equipped with a reel and hand ratchet. We use more hand ratchets in removing stoppages than anything else. Of course, we have the reeling machines, but nine times out of ten, when it is raining and a reeling machine gets out in the rain, you will spend more time starting the motor than it will take to do the job with a hand ratchet.

Mr. Preen:—As far as flooded basements are concerned, we have, at the present time, an ordinance in effect which requires that back-flow valves be installed where necessary. The ordinance has not been tested in court, but Santa Monica, Calif., has a similar ordinance which has been tested. The ordinance is retroactive. Any time the city engineer wishes, he can insist that a back-flow valve be installed and kept working.

DEEDS AND DATA

"Where there is no hope, there is no endeavor."—Samuel Johnson

Highlights from the Annual Reports of Alexandria, Va., Cincinnati,* Ohio, Sonoma Valley County, Calif., Toledo,† Ohio, and Union City, Tenn.

JAMES J. CORBALIS, JR., ‡ *Engineer-Director, Alexandria, Va., Santitation Authority;* ARTHUR D. CASTER, *Principal Sewage Disposal Engineer, Cincinnati, Ohio;* MELVIN F. KLEMMICK, *Chief Operator, Sonoma Valley County, Calif., Sanitation District;* ARTHUR H. NILES, *Commissioner of Sewage Disposal, Toledo, Ohio;* A. L. STRUB, *Superintendent, Union City, Tenn.*

Editors's Note:—Over the years there has been a gratifying response to the appeal for submission of annual reports to THIS JOURNAL. This happy result led us into the small dilemma of having more material than we were able to print in "Interesting Extracts from Operation Reports," the title under which this information was formerly published. In an attempt to solve this problem we have decided to consolidate some of the outstanding items under the new title of "Deeds and Data."

Your comments and suggestions on this new method of handling annual reports will be appreciated.

Industrial Wastes

At Sonoma Valley County, Calif., brandy wastes interfered with the start-up of the sludge digester at the County Sanitation District's treatment plant. Treatment efficiency also was reduced. Laboratory observations indicated that tartrates accounted for between 50 and 75 per cent of the BOD and nearly all of the buffering capacity of the stillage. The wastes were detartrated at the winery and the tartrates were recovered. Lime was added to adjust the pH. Additional work is needed to solve all problems associated with this waste but treatment plant operation has been improved greatly.

At Toledo an industrial wastes inspector has been employed. Through this inspection service the strength of the various industrial wastes entering the sewers will be measured and the cost for treating high-strength wastes will be established.

At Union City, Tenn., the addition of increased amounts of packing house wastes has overloaded the plant. The facilities were designed for a flow of 1.23 mgd and a BOD population equivalent of approximately 15,700. In 1957 the average flow was 1.37 mgd and the population equivalent was 31,370. Recommendations for enlargement are being studied.

Operations

Operating data for Alexandria, Va., Cincinnati, Ohio, Sonoma Valley County Sanitation District, Calif., Toledo, Ohio, and Union City, Tenn. are listed in Tables I, II, III, IV, and V, respectively.

Safety

A comprehensive safety program was initiated in Cincinnati with the employ-

* For last previous abstract see THIS JOURNAL, **29**, 7, 829 (July 1957).

† For last previous abstract see THIS JOURNAL, **28**, 10, 1310 (Oct. 1956).

‡ At present, Engineer-Director, Fairfax County (Va.) Water Authority.

TABLE I.—Operating Data from the Alexandria, Va., Sewage Treatment Plant * for 1957

Item	Average
Population served, est.	85,000
Total rainfall (in.)	31.32
Air temperature (°F)	54.7
Sewage flow:	
Avg day (mil gal)	7.86
Max day (mil gal)	26.11
Min day (mil gal)	4.74
Per capita (gpd)	92.5
Screenings (cu ft/mil gal)	5.5
BOD:	
Plant influent (mg/l)	257
Plant influent (lb/day/cap)	0.20
Primary clarifier effluent (mg/l)	123
Final effluent (mg/l)	78
Reduction (%)	70
SS:	
Plant influent (mg/l)	220
Plant influent (lb/day/cap)	0.17
Primary clarifier effluent (mg/l)	99
Final effluent (mg/l)	78
Reduction (%)	69
Trickling filters:	
Hydraulic loading (mgd/acre)	14.5
BOD loading (lb/day/acre-ft)	2,348
Recirculation ratio	1.1
Raw sludge:	
Volume (1,000 gpd)	49.4
TS (1,000 lb/day)	14.1
VS (1,000 lb/day)	9.8
Digester loading (lb of VS/day/cu ft)	0.43
Gas production and utilization:	
Produced (cu ft/day/cap)	1.2
Yield (cu ft/lb of VS added)	10.1
Yield (cu ft/lb of VS destroyed)	17.5
Utilized (mil cu ft)	15.7
CO_2 (%)	32
Digested sludge:	
Volume (gpd)	12,200
TS (%)	6.2
VS (% of TS)	49
Sludge conditioning and dewatering:	
CaO added (%, dry solids basis)	6.1
$FeCl_3$ added (%, dry solids basis)	3.4
Sludge cake produced (1,000 lb/day, wet)	26.2
Cake moisture (%)	75.5
Filter yield (psf/hr, dry)	6.6

* High-rate trickling filter plant.

ment of a safety engineer. At the Little Miami Works, the newly formed accident prevention committee already has made 108 recommendations, 72 of which are now in effect. The successful experiences of the Little Miami committee resulted in the formation of similar committees for the laboratories, Mill Creek plant, and the samplers and gaugers.

Sewage Characteristics

Studies were started to determine the effects of ground garbage on Cincinnati's sewage. Gauging and sampling operations were performed in certain subdivisions where all houses are equipped with garbage grinders. Similar data were collected from areas having few, it any, grinders. Large grinders used in industrial establishments were also the subject for comparative studies. Some early results from this continuing study are listed below:

Constituent	Sewage* Without Garbage	Sewage† with Domestic Garbage	Sewage‡ with Ind. Garbage
BOD:			
(mg/l)	138	442	1248
(lb/day/cap)	0.11	0.217	0.024
SS:			
(mg/l)	175	375	619
(lb/day/cap)	0.14	0.169	0.012
Ether soluble material:			
(mg/l)	49	231	343
(lb/day/cap)	0.038	0.113	0.007

* Residential area; population, 1,164; all houses have grinders.

† Residential area; population 1,200; few or no grinders.

‡ Industrial plant; 900 employees; commercial-type grinder; fifteen per cent of poundage assumed to come from office and 85 per cent from the cafeteria.

Sewers

At Cincinnati an electric flood control board has been built. The board shows the location, elevation, and type of each storm-flow regulator used on the collection system. Green and red lights indicate whether a valve is to be opened or closed, depending on the river stage. Inspection of the regulating chambers as well as the deep sewers is done by closed-circuit television. The mobile television unit is trailer mounted and cost about $7,500.

In conjunction with Cincinnati's explosive-gas testing program daily testing has been replaced by a monitoring system. Cloth bags containing activated carbon are hung in key manholes

TABLE II.—Operating Data from the Little Miami Sewage Works,* Cincinnati, Ohio, for 1956 and 1957

Item	Average 1956	1957
Flow (mgd)†	13.12	14.1
Total rainfall (in.)	39.8	51.7
Grit (cu ft/mil gal)	3.6	2.2
pH, influent	7.6	7.6
Settleable solids (ml/l):		
Influent	6.4	5.6
Effluent	0.2	0.2
SS:		
Influent (mg/l)	254	223
Effluent (mg/l)	98	84
Removal (%)	61	62
BOD:		
Influent (ppm)	152	147
Effluent (ppm)	88	86
Removal (%)	42	42
Sludge digestion‡:		
Total dry solids fed (mil lb)	8.7	7.3
Raw sludge solids (%)	7.3	6.6
Volatile solids, raw (% of TS)	62.6	64.5
pH	6.0	6.0
Volatile acids (mg/l as acetic acid)	1,250	1,430
Gas (1,000 cu ft)¶:		
Produced	45,264	42,622
Utilized:		
Heating	18,444	16,353
Incineration	8,485	7,201
CO_2 (%)	34.5	34.1
Sludge filtration:		
Rate (psf/hr)	1.5	1.9
$FeCl_3$ dosage (%)	6.1	5.7
Sludge incineration:		
Cake, wet (tons)	4,931	4,394
Solids (%)	34.3	31.9
Ash (tons)	911	759

* Primary treatment plant.
† Includes all recycled liquors. Allowance made for recycled flow to obtain raw sewage values.
‡ Includes solids from recycled plant processes.
¶ Quantities are "as metered"; waste gas not metered.

TABLE III.—Operating Data from the Sonoma Valley County, Calif., Sewage Treatment Plant * for the Fiscal Years 1956, 1957, and 1958

Item	Average 1956	1957	1958
Flow (mgd)	1.5	1.2	2.0
Total rainfall (in.)	40.4	20.6	47.3
Grit (cu ft/mil gal)	3.0	4.8	2.2
BOD:			
Plant influent (mg/l)	454	398	390
Primary clarifier effluent (mg/l)	291	236	271
Filter effluent (mg/l)	142	120	144
Final effluent (mg/l)	118	80	106
Reduction (%)	72	80	63
SS:			
Plant influent (mg/l)	407	460	382
Primary clarifier effluent (mg/l)	210	223	187
Filter effluent (mg/l)	192	220	188
Final effluent (mg/l)	91	98	94
Reduction (%)	78	79	76
DO:			
Plant influent (mg/l)	0.7	0.2	Nil
Primary clarifier effluent (mg/l)	1.7	1.2	1.0
Filter effluent (mg/l)	3.8	3.8	3.0
Final effluent (mg/l)	3.5	2.6	2.4
Sludge:			
Raw sludge:			
pH	6.2	6.3	6.0
Total added (mil gal)	5.0	5.1	4.3
TS (%)	3.0	3.4	3.5
VS (% of TS)	74	76	77
Digested sludge:			
pH	7.1	7.0	7.0
Total withdrawn (mil gal)	0.58	0.72	0.28
TS (%)	3.8	3.8	4.8
VS (% of TS)	60	62	59
Gas production (cu ft/lb of VS added)	6.5	6.9	7.6
Chlorine used (lb)	4,461	4,884	4,554
Power consumed (kwhr/day)	923	841	1,054
Operating cost ($/mil gal)	65.65	87.33	46.07

* High-rate trickling filter plant.

for one week. The activated carbon is then extracted with carbon tetrachloride and the extract examined using a spectrophotometer. During 1956 and 1957 approximately 2,200 monitors were placed and examined. Commonly detected materials were gasoline, kerosene, fuel oil, aromatics, and short-chain hydrocarbons. Combustible-gas-indicator readings are taken weekly. Approximately 1.7 per cent of the 2,400 indicator readings taken over a two-year period was positive.

Sludge Digestion and Handling

On Feb. 15, 1958, the facilities for processing the sludge from the Toledo treatment plant into "Tol-e-Gro" were leased to a private operator. During recent years both tonnage and dollar values of Tol-e-Gro have been decreasing. A contributing factor to the de-

creased sales has been the tendency of farmers to use a more concentrated fertilizer.

Mechanical dewatering of sludge continues to be a major operational problem at several plants. At Alexandria, Va., it was found that when the dosage of $FeCl_3$ was 4.6 per cent the filter yield was 5.3 psf/hr, but when using 6.1 per cent of CaO and 2.7 per cent of $FeCl_3$

TABLE IV.—Operating Data from the Toledo, Ohio, Sewage Treatment Plant * for 1956 and 1957

Item	Average 1956	1957
Total rainfall (in.)	33.8	31.0
Air temperature (°F)	47.0	49.4
Sewage temperature (°F)	64.0	64.0
Sewage flow (mil gal):		
Avg day	49.3	51.1
Max day	135.1	101.6
Min day	28.9	30.8
Grit removed (cu ft/mil gal)	2.1	2.8
SS:		
Influent (mg/l)	184	170
Effluent (mg/l)	96	89
Reduction (%)	47	48
BOD:		
Influent (mg/l)	192	169
Effluent (mg/l)	140	106
Reduction (%)	27	38
Digester gas (mil cu ft):		
Produced	80.3	86.5
Utilized	71.8	74.1
Wasted	8.5	12.4
VS (% of TS):		
Raw sludge	66.5	66.7
Digested sludge	44.7	42.0
Digested sludge (cu yd):		
To marsh	22,280	33,210
To drying beds	7,140	5,145
Removed from beds	1,513	1,187
Dry sludge pulverized for fertilizer (tons)	610	474
Fertilizer:		
Sold (tons)	518	488
Value ($)	8,649	9,103
Chlorine:		
Used (lb)	255,540	251,090
Days applied	72	83
Treatment costs ($/mil gal)	11.25	12.03
Gas engine economy ($):		
Pumping cost if power purchased	28,761	28,383
Actual pumping cost	17,958	12,600
Gas engine saving	10,803	15,783

* Primary treatment plant (facilities for secondary treatment under construction).

TABLE V.—Operating Data from the Union City, Tenn., Sewage Treatment Plant * for 1957

Item	Average
Population (est.)	8,300
Population equivalent (BOD basis)	31,370
Flow (mgd)	1.37
Total rainfall (in.)	79.3
SS:	
Influent (mg/l)	288
Effluent (mg/l)	48
Reduction (%)	83
BOD:	
Influent (mg/l)	468
Effluent (mg/l)	88
Reduction (%)	81
Raw sludge dewatering:	
Filtered (mil gal)	1.86
Dry solids (tons)	453
Filtration rate (psf/hr)	5.5
Chemicals added (lb):	
Lime	59,932
Ferric chloride	26,964
Cost ($):	
Lime	749.15
Ferric chloride	3,211.47
Labor	1,866.75
Power	242.27
Water	184.95
Per ton of dry solids	13.80
Total cost of sewage treatment ($/mil gal)	50.47

* Activated sludge plant, roughing filter precedes aeration tanks. For flow sheet see THIS JOURNAL, 29, 5, 595 (May 1957).

the yield increased to 7.4 psf/hr. In early 1958 at Union City, $Fe_2(SO_4)_3$ was substituted for $FeCl_3$ and chemical costs have been reduced by 30 per cent. This plant dewaters raw primary sludge and waste activated sludge.

At Cincinnati, data indicate that certain constituents of the raw sludge, such as mineral oil, clay, and fine organics interfere with digestion, elutriation, and filtration. Clear supernatant has been difficult to draw under ordinary operation. However, a good supernatant is possible when three secondary digesters are used with each primary unit. This method of operation permits longer retention.

Mineral oil is believed to cause scum layers. Mineral oils also interfere with elutriation and tend to float fines through the tanks which causes recycling of much solids. Reasonable filtration rates cannot be maintained because the solids concentration is low and the thin cake, containing oils and fine solids, blinds the filter cloth. Ferric chloride use is not excessive but with thin sludges it produces thin cakes which do not peel off the filter. The filter yield in 1956 was 1.5 psf/hr; in 1957 it was 1.9 psf/hr. Quiescent settling in the elutriation tanks has been helpful in providing a more concentrated sludge.

It has been found in Cincinnati that grease in sludge is reduced by two-stage digester operation (90 to 95°F) to 14 to 18 per cent of the raw sludge value. Little, if any, grease separates in the primary digester because of the agitation. However, sampling of secondary and tertiary tanks shows considerable quantities of grease floating on the surface of these units. Elutriation further reduces the grease content by about 2 per cent. Microscopic examination of the elutriated digested sludge shows few fat globules, which leads to the belief that most of the grease is adsorbed by the sewage solids.

Attention operators! It will be appreciated if copies of all annual reports of both large and small sewage and industrial waste treatment plants are sent to the Federation office for abstracting in this section of the Journal. Please direct annual reports to: The Operator's Corner, Federation of Sewage and Industrial Wastes Associations, 4435 Wisconsin Ave., N.W., Washington 16, D. C.

EXPLOSION PREVENTION *

By John R. Wolfs

Chief Civil Engineer, Division of Sewage Disposal, Cleveland, Ohio

Every little while an explosion occurs in a subway, sewer or trench, or in an electric-wire tunnel or some other subterranean conduit or passageway, under circumstances such that it is exceedingly difficult to determine the cause of the accident satisfactorily.

In some cities explosions of this nature occur frequently, attended by loss of life, personal injuries, and more or less property damage. They have often been attributed to sewer gas, which contains a considerable proportion of methane and hydrogen. These gases are exceedingly combustible, and quite capable of exploding with extreme violence when mixed with air in the right proportion and fired with a spark or a flame. This much is quite generally admitted, but in many cases the difficulty is to account for the ignition of the mixture, when it appears to be impossible to ascribe it to the action of any recognizable external agent, such as electricity or flame.

The article quoted above appeared under the title, "The Spontaneous Explosion of Gas." It was published in 1916 in *The Travelers Standard*—a house organ of the Travelers Insurance Co. The article is as timely today as it was in 1916 and the sources of ignition are just as illusive. Nevertheless, it is possible to use our limited knowledge of sewer explosions to prevent recurrences. This article attempts to describe Cleveland's detection and protection program.

Cleveland Experiences

$2.5 Million Explosion

On Sept. 30, 1953, an explosion took place in a sewer on West 117th St. The cause of the ignition is unknown. Property damage amounted to $2.5 million. The damage suits were settled out of court for amounts unknown.

The report on this explosion (1) listed the following possible sources of explosive materials: (a) natural gas from the upper strata known as shale gas; (b) abandoned natural gas wells; (c) industrial wastes; (d) accidental dumpage, leakage, and spillage of volatiles; and (e) gas mains.

In addition to the 117th St. explosion there have been several other minor explosions. These have occurred in the dump area where quantities of carbon monoxide are thought to accumulate in the sewers under condition of surcharged outfalls, produced by high lake levels.

In April 1955, as an outgrowth of the 117th St. disaster, Cleveland's Industrial Waste Control Unit began routine inspection of the main sewers. At present, the mobile inspection unit consists of a two-man crew trained in the detection of hazardous conditions and equipped with the necessary instruments.

Large Sewers

The sewers most vulnerable to accumulation of explosive conditions are those serving industrial areas. The combined sewers, usually using only a small portion of the total capacity for dry weather flow, together with few connections, tight manhole covers, and long distances are particularly dangerous.

The lack of ventilation in a sewer over a sustained dry weather period produces conditions that make it possible to build up hazardous concentrations, needing only a source of ignition to prove disastrous. The "Barnes Report" (1) showed that various combustible liquids, when exposed to the atmosphere at sewage temperatures, can evaporate in the short transit time available in a sewer. Furthermore, the Report showed that a small constant source, over a long period of time, is

* Presented at the 32nd Annual Meeting, Ohio Sewage and Industrial Wastes Treatment Conf.; Toledo, Ohio; June 18–20, 1958.

much more dangerous than a large dump.

Program Organization

To properly organize a program of industrial waste and gas detection the nature of the sewer system must be evaluated. This means that key personnel should have a good background in sewerage problems.

From a large-scale map of the collection system a data sheet is prepared for each manhole to be inspected. Included on this sheet are the identification of the manhole, size, depth, direction of sewage flow, and type of manhole cover. The inspection routes are arranged to minimize travel time.

The two-man crew is equipped with a ¾-ton station wagon. The vehicle is fitted with a "Mars" light and strips of "Scotchlite." Inspections of sewers in main streets are avoided during rush hours.

Testing of manholes is done with a combustible gas indicator* equipped with a selective switch for detecting petroleum vapors and natural gas. In addition, a Wolf lamp is used for water meter vaults.

Follow-up letters are prepared by office personnel.

Emergency Procedure

If two successive dangerous manholes are found the Fire Prevention Bureau is notified. They, in turn, order a fire company to flush the sewer until pronounced clear by their own personnel. The local gas companies are notified by phone when gas is found in manholes, vaults, or other structures. This information is confirmed by letter. Persistent minor concentrations of gas are handled by requesting the sewer department to supply a grated cover after all known sources are explored.

In the case of a spill of gasoline from a transport truck, the fire department flushes the street and the fire exchange notifies the treatment plant by phone. The plant personnel can then prepare to receive the gasoline that has been flushed from the street.

Results

From inspection results it has been found that only 0.75 per cent of the sewer manholes contained gas in excess of 10 per cent of the lower explosive limit. This, in the case of natural gas, is but a 0.6 per cent concentration. However, it was soon discovered that when a manhole contained gas in concentrations as low as 5 per cent of the lower explosive limit, the various utility vaults in the area were usually explosive.

This discovery proved to be a valuable means of increasing the program's effectiveness for it led to a cooperative arrangement with the water meter readers whereby these men record the presence of gas on a tear-out sheet that is turned over to the detection unit. The vaults are then tested with a combustible gas indicator and a Wolf lamp. Hazardous vaults are reported to the gas companies.

The "Mayor's safety committee" is used to stress the hazard of gas and the effectiveness of detection. The 1957 letter stated:

> The Industrial Wastes Unit tested 838 B.V.'s (brick vaults containing water meters, valves, etc.) during 1956. Almost half of these indicated gas was present. After these were reported "safe" by the gas companies, they were re-checked and only 58 are still hazardous or repairs not finished at the end of the year. It is important to this Unit to have the cooperation of the meter readers and line repair crews and to report all suspicious vaults to your supervisors and to see that this information is submitted to this Division.

As indicated by the results obtained, 95 per cent of the detection work involves leaks in natural gas lines. The gas companies are most cooperative

* Model 51 Explosimeter, manufactured by the Mine Safety Appliance Co.

and follow up all reports with diligence.

Plant Protection

Protection for the plant and pump stations can be handled by instrumentation. Accidental dumps, spills, and undetected conditions can be handled automatically by an alarm system. Accordingly, it is recommended that all pump stations be fitted with an automatic, indicating combustible gas indicator which will stop the pumps or perform other functions when high concentrations of volatiles are encountered.

Treatment plants should be designed so as to ventilate the main interceptor outside the building. A screen room should be sampled to see if the atmosphere contains explosive mixtures. The Cleveland plants are ventilated with auxiliary blowers. Favorable experience has been recorded with one automatic combustible gas indicator. This unit sounds a horn and starts the ventilating equipment.

Summary

1. Testing of sewers revealed that 0.75 per cent of the manholes tested contained gas concentration in excess of 10 per cent of the lower explosive limit.
2. In 45 per cent of suspicious vaults reported by water meter readers explosive mixtures were detected.
3. Repairs to leaks in the gas mains near the vaults resulted in virtual elimination of gas in the area.
4. Routine sampling of sewers prevents a build-up of undetected gas.
5. Detection of most accidental dumps is impossible. Only education of the public will solve this problem.

Reference

1. Barnes, G. E., "Industrial Wastes or Gasoline Caused $2,500,000 Explosion." *Wastes Eng.*, **25**, 11, 542 (1954).

TIPS AND QUIPS

Safety

The 1958 catalog section of *National Safety News* is now available. This 61-page catalog is published by the National Safety Council. Safety manuals, data sheets, pamphlets, leaflets, posters, signs, and films are briefly described and prices are given.

Whether your staff is large or small this catalog should prove to be a valuable addition to your reference shelf.

Sniffing by Instrument *

Since the dawn of time, the No. 1 technique in smell research has been, of course, to smell—or what scientists call "organoleptic observation." Human beings, provided no head colds or emotional upsets interfere, can actually detect an odor produced by 1/25,000,000,000th of a drop (that is, 4×10^{-14} gram) in one whiff (50 cc) of air.

However, two Australian chemists recently took a 1/100th-milliliter sample containing 1 part of diethyl ether in 10,000,000 parts of ethyl acetate and detected the ether with a sensitivity of 4×10^{-10} gram—without using their noses at all! They turned, instead, to ultra-sensitive gas chromatography instrumentation. So did the two Quartermaster Research and Development Center chemists in Natick, Mass., who have finally solved the 64-year-old research riddle of why an onion smells (certain disulfides hitherto thought innocent).

Throughout 1958, chemists—evidently undaunted by that formidable natural competitor, the human nose—have been closing in on the secrets of scent.

* *The Laboratory*, **27**, 2, 38 (1958).

SUPPORT THE Clean Streams PROGRAM
IS THIS YOUR Stream
YOU CAN CHANGE IT
VOTE
FOR LAWS AND MONEY TO CONTROL STREAM POLLUTION
PUSH BUTTON

FIGURE 1.—Pennsylvania's award-winning "Clean Streams" exhibit.

Clean Streams Exhibit

The Pennsylvania Department of Health's exhibit on clean streams was awarded top honors at the 86th annual meeting American Public Health Association.

The exhibit, which shows the value of water pollution control, was one of eight selected by the judging board as outstanding from 150 technical and scientific entries.

Pennsylvania's display (Figure 1) illustrates how an area, blighted by water pollution, can become attractive to both industry and sportsmen after pollution is eradicated through industrial waste and sewage treatment plants.

Chloride Determinations

Recently the Fisher Scientific Company announced availability of reagent-grade mercuric chloranilate. Used directly in a pH 2.0 solution containing the chloride, it yields mercuric chloride and acid-chloranilate ion. The amount of the latter liberated is directly proportional to the chloride ion. Fisher claims a micro chloride determination can be carried out in minutes. A further claim is that as little as 0.2 ppm chloride can be detected in the visible region.

Photography

The Buffalo, N. Y., Sewer Authority maintains a pictorial record of items of value and interest. Pictures of construction work as well as photographs for study and legal purposes are titled, filed, and indexed. Last year 294 pictures were added to the permanent records of the Authority, bringing the total number of photographs on file to 5,373.

Editorial

ANNUAL OPERATING REPORTS

Water pollution control is public business. Those who operate facilities require public support. In turn, the public expects results.

It is as if the treatment works were at one end of a street and the public at the other. But this is a two-way street. At the other end must be an informed citizenry if pollution abatement is to continue. If the public is to be informed, the official in charge of the treatment works has an inescapable responsibility. He must present his case clearly and frequently. He must account for past actions and bring meaning to his technical data. He must forecast new demands and initiate appropriate action, for waste treatment is never at a standstill.

In connection with this responsibility, the annual report is a useful instrument. Now, the annual report cannot be all things to all people. Hence if it is to be a report to the public, the public should be able to understand it. Overwhelming the reader with technical terms and data is self-defeating and warmed-over reports from previous years are cast aside. This does not mean technical information must be excluded. It means, rather, that technical information must be incorporated skillfully so as not to detract from the major objective. Reports are judged neither on length nor brevity; they are judged on substance and readability.

Reports received at Federation headquarters (for which we are truly grateful) come in nearly every size, shape, and color. They come from small and large plants located inside and outside the United States. In general, they are good, solid pieces of work that undoubtedly accomplish their purposes.

Each year the number of new annual reports continues to increase, but the total is still woefully inadequate. Reports from industrial wastes treatment works seem severely restricted in circulation.

The Federation has for many years recognized the importance of annual reports. Specifically, the William D. Hatfield Award is based on the operator's achievements in the field of public relations and his outstanding annual report in addition to his general technical and administrative competence.

More reports are needed. The public needs to be informed for "There is nothing as frightening as ignorance in action."

Even though all reports cannot be reported in detail, the receipt of all reports by the Federation is desirable. With the increase in plants, a continuous selection is necessary for reporting in THIS JOURNAL. In this issue a new method of preparing this information is presented as "Deeds and Data." The aim of this presentation is to offer information on groups of plants in a more concise fashion. If it is well received by you, it will replace the "Interesting Extracts" used in previous issues. May we have your comment?

R. E. F.

Reviews and Abstracts*

How Radioactive Wastes Will be Handled at PWR. By J. R. La Pointe. *Nucleonics*, 15, 5, 114 (May 1957).

Wastes from the PWR at Shippingport will vary and include activated corrosion products, fission products from possible fuel-element rupture, radioactively contaminated tools, spent resins used in removing radioactivity from recirculated cooling water, combustible wastes, radioactive gases, etc. Design criteria were such that nonvolatile wastes would be disposed of at concentrations not exceeding 10 per cent of the MPC value listed for an unidentified mixture of radioisotopes, and that sufficient storage capacity had to be provided for storage of radioactive gases for the maximum expected duration of a weather inversion (five days used). To meet these criteria, the PWR waste system uses (a) natural decay, (b) concentration and storage, and (c) dilution. The details of handling specific wastes are outlined. PHEA.

Conrad P. Straub

The Effect of Contaminants on the Rate of Aeration of Water. By A. L. Downing, K. V. Melmourne, and A. M. Bruce. *Jour. Appl. Chem.* (*Brit.*), No. 7, 590 (1957).

Household detergents added to pure water to give a concentration of anionic surface active agents of 1 to 15 ppm and agitated in different ways to give a wide initial range of exchange coefficients showed that the exchange coefficients decreased rapidly up to 0.5 ppm surfactant concentration and then more slowly (reductions of 20 to 60 per cent). The reduction in exchange coefficient depends in addition on the initial exchange coefficient and upon the way the water is agitated. The addition of alkyl aryl sulfonate to pure water in concentrations of 0.07 to 0.73 ppm reduced the exchange coefficient by 40 per cent.

Detergent-free sewage treated by activated sludge and trickling filter when added in 10 per cent volume concentration to water and stirred in a rectangular vessel or flowing channel reduced the exchange coefficient by 5 to 25 per cent, depending on the initial exchange coefficient. Ten per cent of filter effluent added to water with a concentration of surface-active material of 0.2 ppm in the mixture and aerated as in the previous experiments showed greater reductions in the exchange coefficient. Activated sludge effluent (13 per cent by volume in clean water) with an ultimate detergent concentration of 1.2 ppm decreased the exchange coefficient by 26 per cent.

H. Heukelekian

Biological Oxidation of Sugar-Based Detergents. By P. C. G. Isaac and D. Jenkins. *Chem. and Ind.* (*Brit.*), p. 976 (1958).

The effect of the sugar-based detergents, Sucrodet D-600 and Sequol-260, on the uptake of dissolved oxygen from seeded BOD dilution water is studied. The presence of these detergents stimulates the uptake of oxygen, the stimulation increasing with the amount of detergent added.

Similar experiments with 10 ppm tetrapropylene-benzene-sulfonate show that this substance has no significant stimulatory effect on the uptake of oxygen under these conditions.

The experimental method is described and the results are expressed in graphical form.

D. Jenkins

* Please send to Federation headquarters all periodicals, bulletins, special reports, etc., which might be suitable for abstracting in This Journal. Publications of public health departments, stream pollution control agencies, research organizations, and educational institutions are particularly desired. Address such material: Federation of Sewage and Industrial Wastes Assns., 4435 Wisconsin Ave., N.W., Washington 16, D. C.

CONSTITUTION AND BYLAWS

FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

Adopted January 15, 1941. As amended to February 4, 1958.

CONSTITUTION

ARTICLE I. Name

The name of this organization shall be the Federation of Sewage and Industrial Wastes Associations, hereinafter designated as the Federation.

ARTICLE II. Objectives

The objectives of this Federation shall be: The advancement of fundamental and practical knowledge concerning the nature, collection, treatment and disposal of sewage and industrial wastes; the design, construction, operation and management of sewer systems and treatment works; the study, promotion and encouragement of improved sanitation of waterways; the correlation and strengthening of regional and state sewage and industrial wastes associations or conferences within or without the United States of America; the publication of a journal; and other relevant activities.

ARTICLE III. Membership

The membership of the Federation shall consist of regional or state associations or conferences, either within or without the territory of the United States of America, hereinafter designated as Member Associations, whose objectives and constitutions are in harmony with the purposes of this Federation, and of individuals or corporations as specified in the Bylaws, subject to the conditions and limitations prescribed in the Constitution and Bylaws of the Federation.

ARTICLE IV. Organization

SECTION 1. The affairs of the Federation shall be conducted by a Board of Control (hereinafter designated as the Board) under such rules as the Board may determine, subject to the specific conditions of this Constitution and Bylaws.

SECTION 2. The officers of the Federation shall be a President, a Vice-President, a Secretary, and a Treasurer.

SECTION 3. The Board shall consist of:

(a) The President of the Federation.
(b) The Vice-President of the Federation.
(c) The Treasurer of the Federation.
(d) One Director to be appointed by and to represent each Member Association. One additional Director to be named by each Member Association which has maintained a total Active plus Corporate membership of 500 or more for the three preceding successive years ending on September 30.

(e) Six Directors-at-Large, of whom three are to be elected by the Board of Governors of the Water and Sewage Works Manufacturers Association, and three by the Directors representing the Member Associations.
(f) The latest living Past President of the Federation.

SECTION 4. The terms of office of the President, Vice-President, and Treasurer shall be one year, and the Directors three years, which terms shall start at the beginning of the last session of the Annual Meeting of the Board at which they are elected and continue until a successor qualifies. The Secretary shall be appointed by the Board for the term of office stated in the Bylaws. In the case of a vacancy in the office of President, the Vice-President shall act in his place for the unexpired term. In case the Vice-President cannot act, the latest living Past President shall do so. In the case of a vacancy in the office of Treasurer or of any Director-at-Large representing Member Associations, the Executive Committee shall appoint an Active Member to fill such office for the unexpired term. Any vacancy occurring among the Directors-at-Large elected by the Manufacturers Association shall be filled by the Board of Governors of that Association.

SECTION 5. The President shall be ineligible for re-election. The Vice-President and Directors shall not be eligible for reappointment or for re-election to the same office until at least one full term shall have elapsed after the end of their respective terms.

SECTION 6. The President of the Federation shall be the Presiding Officer of the Board.

SECTION 7. A quorum of the Board shall consist of a majority of its ex-officio members, Directors-at-Large, and those Directors representing Member Associations within the territory of the United States of America and of Canada. Any member of the Board, except the President, Vice-President, or Treasurer may designate a proxy to act for him if he is unable to attend a meeting in person. Such proxies shall be designated in writing by the absentee Board member from the same Member Association, or organization he represents. All such proxies shall be counted in determining a quorum. Only in the event of a lack of a quorum at an Annual Meeting shall the chair be authorized to appoint proxies and then only from the absentee Member Association or organization, if such representation is available. In no case shall any individual cast more than one vote.

ARTICLE V. Nomination and Election of Officers and Directors

SECTION 1. The Annual Meeting of the Board shall be held during the Annual Convention of the Federation on such day or days as may be decided by the Board. In event there is no Annual Convention of the Federation the Annual Meeting of the Board shall be in the office of the Federation on the third Saturday in October. Other meetings of the Board may be held as provided in the Bylaws.

At the Annual Meeting the Directors representing the Member Associations shall meet under the chairmanship of the President of the Federation, and shall by a majority vote of all such Directors voting, elect a President, Vice-President, Treasurer and one Director-at-Large. Absent Directors may vote by proxy, in accordance with procedure defined in Article IV, Section 7 of this Constitution. Any candidate so elected shall be an Active Member of some Member Association and shall signify willingness to serve. Any candidate elected as President or Vice-President shall at some time previous to such election have been a member of the Board of Control.

SECTION 2. One Director on the Board of Control to represent each Member Association shall be elected by each Member Association. One additional Director is to be elected by each Member Association which has maintained a total Active plus Corporate membership of 500 or more, for the preceding three successive years ending on September 30. Each Director so elected shall be an Active Member of the respective Member Association and in good standing at the time of his election.

In the case of any Director, representing a Member Association, retiring for any cause before his term is completed, or who fails to remain in good standing in his

Member Association, the governing board of the Member Association shall designate his successor, who shall serve for the unexpired portion of his term.

ARTICLE VI

Except as specifically mentioned herein, this Constitution shall take effect immediately upon its adoption by the Board of Control.

ARTICLE VII. Amendments

Amendments to this Constitution may be made by a two-thirds vote of the total membership of the Board present or represented by proxy, notice of the proposed amendment having been given to each member of the Board and to the Secretary of each Member Association not less than sixty days in advance of the meeting, at which the said amendments are to be voted upon.

BYLAWS

ARTICLE I. Member Associations

SECTION 1. Any regional or state association or conference, or other organization whose objectives and constitution are in harmony with those of the Federation, may be granted membership in the Federation by a majority vote of the Board; provided, that the constitution of the applicant association or conference has been examined and certified by the Board as being in accord with Article III of the Constitution of this Federation; and provided further, that certification shall be made by the association seeking admission to membership that the Constitution and Bylaws of the Federation are accepted by it.

SECTION 2. If a group of Active and Corporate Members affiliated with the Federation is part of an organization which has an interest in major fields other than sewage and industrial wastes, this group shall be established as the sewage and industrial wastes section of the organization and shall have its own constitution and bylaws provisions. The section shall be considered the official Member Association of the Federation. The officers and Director to the Federation of such section shall be Active Members. All officers of this section shall be elected by the section membership. The section or its executive committee shall have at least one meeting per year.

SECTION 3. Member Associations may affiliate with or establish other associated groups as an adjunct to its over-all coverage of the sewage and industrial wastes field. Classification of membership for such affiliates shall be determined by the Member Association but shall not include Associate Members or Sustaining Members which classes of membership are reserved to the Federation. The affiliated groups shall be represented on the Executive Committee of the Member Association. The affiliate's President or Chairman, its Secretary, and its representative to the Member Association shall be Active Members.

SECTION 4. Any Member Association may withdraw from the Federation at the end of any fiscal year by giving three months' notice of such intention, provided that the dues of such Member Association in the Federation are fully paid up to time of withdrawal.

SECTION 5. Any Member Association may be excluded from this Federation, at the pleasure of the Board, for non-payment of dues, as hereinafter provided, or for any change in its constitution that may bring it into conflict with the Constitution or Bylaws of the Federation.

SECTION 6. Any change in the existing constitution or bylaws of a Member Association shall be reported in full to the Secretary of the Federation within thirty days after its adoption by said Member Association.

ARTICLE II. Classification of Members

SECTION 1. Membership of the Federation shall be composed of Member Associations, Honorary Members, Associate Members and Sustaining Members. Membership in the Member Associations shall consist of Active Members, Corporate Members and such other members as shall be determined by the Member Association and as provided for in Article I, Section 3 of the Bylaws. Only Active Members and Corporate Members shall be certified to the Federation.

SECTION 2. Without changing the basic concept of Federation membership, an Active or Corporate Member may identify himself as a member of the Federation of Sewage and Industrial Wastes Associations.

SECTION 3. An Active Member shall be a superintendent, manager, operator, or employee of a sewage or industrial wastes system or treatment works; a professional engineer; a chemist, bacteriologist, biologist, or any qualified person professionally engaged or interested in the advancement of knowledge relating to the disposal or treatment of sewage and industrial wastes or improved sanitation of waterways.

SECTION 4. A Corporate Member shall be a Sewerage Board, Department or Commission; Sanitary District; Department of Public Works handling sewerage; Industrial Corporation; National, State, District or Municipal Board or Department of Health; or other body, corporation or organization engaged or interested in at least one of the stated objectives of the Federation, and shall be entitled to one representative whose name shall appear on the roll of members and who shall have all the rights and privileges of an Active Member. This representative may be changed at the convenience and pleasure of the Corporate Member on written notice to the Secretary of the Member Association to which the Corporate Member is accredited.

SECTION 5. An Honorary Member shall be a person of acknowledged eminence in one or more fields of activity within the scope of the stated objectives of the Federation. Candidates may be nominated by any Member Association or by a special committee appointed by the Board but can be elected only by favorable secret ballot vote of the Board. Two negative votes shall exclude. No election to Honorary Membership shall be made which would cause the total number of Honorary Members to exceed a ratio of one Honorary Member to every 350 Active Members. Not more than two Honorary Members shall be elected in any calendar year. Honorary Members shall be elected for life, shall pay no dues, and shall receive, without cost, all the publications of the Federation that are distributed to its members.

SECTION 6. An Associate Member shall be a person, firm, or corporation engaged in the manufacturing or furnishing of supplies, materials, or equipment for the construction, operation or maintenance of sewage or industrial waste facilities, and shall be elected by affirmative vote of a majority of the Board after consideration of written application duly made to the Secretary.

SECTION 7. A Sustaining Member shall be an individual or a corporation interested in the general objectives of the Federation.

ARTICLE III. Dues

SECTION 1. The status and dues of the different classes of members established by the Member Associations, as applied to their members, shall be as determined by the Member Association.

SECTION 2. (a) For each Active Member the annual dues shall be as determined by the Board, payable in advance by the Member Associations to the Secretary of the Federation.

(b) For each Corporate Member the annual dues shall be as determined by the Board, payable to the Secretary of the Federation by February 1 of each year.

(c) For each Sustaining Member and each Associate Member the annual dues shall be as determined by the Board, payable to the Secretary of the Federation by February 1 of each year.
(d) Corporate Members, Sustaining Members, or Associate Members whose dues remain unpaid on March 1 of any year may be dropped from membership on action of the Executive Committee.
(e) The dues for Member Associations outside the United States of America and its territorial possessions shall be greater than the amounts hereinbefore specified by an amount to be fixed annually by the Board as equivalent to the added cost for mailing the Journal to such associations as compared with the average cost for mailing to members residing within these limits.
(f) Active Members, paying full dues, and Corporate Members of Member Associations, and Associate and Sustaining Members of the Federation, in good standing, shall be entitled to one copy each of all publications that are distributed by the Federation to its members.

SECTION 3. The fiscal year of the Federation shall begin on January 1, and annual dues shall be collectible on that date and shall have been paid before February 1. If the dues of any Member Association shall not have been paid by February 1, fifteen days notice of the dues in arrears shall be given to that association, after which time, if the dues remain unpaid, that association may be dropped from the rolls of the Federation on action by the Board, as provided in Article I, Section 3, of these Bylaws.

SECTION 4. Any member, newly elected before June 30, shall pay full dues and shall be entitled to all the publications of the Federation that are distributed to its members during the year. Members elected after June 30 shall pay one-half the regular dues for that year, and shall be entitled to all of the publications distributed during the half year beginning July 1.

SECTION 5. In transmitting dues to the Federation, each Member Association shall forward with them a list of the names, professional titles and correct mailing addresses of all members of all classes of the said Association who are in good standing and are entitled to receive the Journal or other distributed publications of the Federation during the ensuing year.

ARTICLE IV. Duties of Officers and Directors

SECTION 1. The President shall have general supervision of the affairs of the Federation, and shall preside at all conventions of the Federation and meetings of the Board. In his absence the Vice-President shall preside. Should both be absent the Board shall elect the Presiding Officer. The President shall be, ex-officio, a member of all committees.

SECTION 2. The Vice-President shall assist the President in the performance of his duties, and act in his stead when required.

SECTION 3. The Board of Control shall be the legal representative of the Federation, and as such shall manage its affairs subject to the conditions and limitations prescribed in the Constitution and Bylaws; direct the investment and care of funds of the Federation; make appropriations for specific purposes; appoint employees and fix their compensation; take measures to advance the interests of the Federation; and generally direct its business. The Board shall not incur indebtedness beyond the funds in the hands of the Treasurer and the Secretary. The Board shall hold a meeting during the Annual Convention. Other meetings shall be held at the call of the President, or on petition addressed to the Secretary and signed by ten or more members of the Board representing not less than seven Member Associations. Notice of all meetings shall be issued by the Secretary at least fifteen days in advance of such meetings to all members

of the Board and to the Secretary of each Member Association. In the event of a vacancy in the office of Secretary, notices of meetings will be issued by the President.

At the Annual Meeting the Board shall appoint a Secretary to serve for a term of two years, unless removed for cause by the Board.

Except as otherwise provided in the Constitution and Bylaws, all questions before the Board shall be decided by a majority vote of those present.

SECTION 4. The Treasurer shall have charge of the funds of the Federation and custody of its investments, if any. He shall pay bills against the Federation when certified by himself and the Secretary. He shall make a report for each calendar year at the Annual Meeting of the Board, showing receipts from the Secretary and other sources, the expenditures, the investments and other assets, and the liabilities of the Federation. He shall make such other reports as may be required by the Board.

He shall be bonded at the expense of the Federation, and to an amount to be determined by the Board.

He shall perform such other duties as may be assigned to him by the Board.

SECTION 5. The Secretary shall be an Active Member and, under the direction of the President and the Board of Control, shall be the executive officer of the Federation. It shall be his duty to attend all conventions and meetings of the Board, prepare the business and duly record the proceedings thereof. He shall see that all monies due the Federation are carefully collected and without loss transferred to the custody of the Treasurer. He shall scrutinize all expenditures, shall certify to the accuracy of all bills and vouchers on which money is to be paid, and shall countersign checks drawn by the Treasurer against the funds of the Federation when such drafts are known by him to be proper and duly authorized by the Board. Once every three months he shall forward to each member of the Board a financial summary of receipts and disbursements, and at the Annual Meeting of the Board shall present a balance sheet of his books as of the 31st of December and as of the 30th of September preceding the meeting, together with a report of the activities of his office.

He shall have charge of the books and records of the Federation, including lists of members of the Federation and subscribers to the Journal. He shall have charge of the mechanical production and distribution of the Journal and other publications of the Federation, and shall handle all financial matters connected therewith.

He shall be bonded at the expense of the Federation, and to an amount to be determined by the Board.

The books of the Federation shall be audited annually at the expense of the Federation by public accountants to be appointed by the Board.

In the event that the Secretary or Treasurer shall be unable to sign checks against the funds of the Federation, the President or Vice-President shall be authorized to countersign such drafts in his stead.

SECTION 6. The Secretary shall serve as Editor of all publications of the Federation and shall receive all manuscript copy and prepare it for publication. He shall have the authority to return to the author for correction, or to reject entirely, any manuscript which may be in bad condition, illegible, or clearly deficient in respect to composition, subject matter or supporting data, or otherwise conspicuously deficient or unfit for publication. He also shall have the authority to reject any manuscript which is designed to promote commercial interests. He shall be a member of the Publications and Program Committee and of the Committee on Sewage and Industrial Wastes Practice. Decisions of the Editor relative to rejection of manuscripts shall be subject to appeal to the Publications and Program Committee.

ARTICLE V. Conventions of the Federation

The Annual Convention of the Federation shall be held at a time and place selected by the Board, preferably in the month of October. All conventions and meetings shall be conducted according to "Roberts Rules of Order," except where provisions to the contrary are noted in any Article herein.

Each member and guest present at any of the conventions of the Federation shall pay a registration fee of such amount as may be determined by the Executive Committee.

ARTICLE VI. Committees

SECTION 1. There shall be an Executive Committee of seven members consisting of the President, Vice-President, immediate Past President and four Directors. This committee shall be chosen by the Board at its Annual Meeting. The President of the Federation shall be Chairman, and the Secretary of the Federation shall act as Secretary of the committee. In the absence of the President, the Vice-President shall preside. The duties of this committee shall be to direct the administrative work of the Federation and carry out the policies of the Board between meetings of the latter. A quorum of the committee shall be four members.

SECTION 2. A Publications and Program Committee shall be appointed by the Board at its Annual Meeting. It shall consist of the Secretary and four or more Active Members of which at least three shall be Members-at-Large. The Publications and Program Committee shall arrange the technical programs for the Annual Convention of the Federation. The committee shall prepare general rules which, after approval by the Board, shall control the preparation, presentation, acceptance and publication of papers and shall have general supervision of such other matters of similar nature as the best interests of the Federation may require.

SECTION 3. An Organization Committee of five Active Members of which at least three shall be Members-at-Large shall be appointed by the Board at the Annual Meeting. The Organization Committee shall examine and report to the Board on application for membership in the Federation and also serve in the encouragement of the formation of new regional or state associations or conferences eligible for membership, as well as serving in an advisory capacity in other matters of a similar nature as the best interest of the Federation may require.

SECTION 4. A Sewage and Industrial Wastes Practice Committee consisting of the Editor and four or more Active Members of which at least three shall be Members-at-Large shall be appointed by the Board at the Annual Meeting.

Any publication which undertakes to establish in the name of the Federation, professional or technical standards shall be submitted by this committee to the Board for approval.

It shall give notice by publication to the membership of all such approved standards and publications.

It shall appoint such subcommittees as it may deem necessary to carry on its work.

SECTION 5. There shall be a Research Committee of five or more Active Members of which at least four shall be Members-at-Large.

The Research Committee shall be charged with the duty of stimulating and coordinating research work among the various Member Associations, and of cooperating with other organizations in the promotion of research work.

SECTION 6. There shall be a Finance Committee of five members consisting of the President, the latest living Past President, the Treasurer, and two Members-at-Large, one of whom shall be appointed Chairman and the other Vice-Chairman. The committee shall present at the Annual Meeting of the Board a budget of estimated expenses of the Federation, including publications, for the ensuing year. On the adoption of the budget by a majority vote of the Board members present, expenses of the Federation shall be limited, as far as may be practicable, within the amounts prescribed in said budget.

The committee shall also function in a general advisory capacity to the Board and to the Executive Committee in all matters relating to finances of the Federation.

SECTION 7. There shall be a Committee on Standard Methods of Sewage and Industrial Wastes Analysis of five or more Active Members of which at least four shall be Members-at-Large.

The committee shall be charged with the duty of developing, perfecting and modifying standard methods for the analysis of sewage and industrial wastes and of sludges or by-products therefrom, and of cooperating with other organizations interested and engaged in similar work.

SECTION 8. There shall be a Committee on Industrial Wastes consisting of five or more Active Members of which at least four shall be Members-at-Large.

The committee shall be charged with the duty of stimulating interest in, and of being of service to industry in the varied problems encountered in the industrial wastes field, including cooperation between Member Associations, and other organizations and agencies.

SECTION 9. Each of the Committees listed in the preceding Sections shall at the time of appointment, include a Vice-Chairman.

SECTION 10. All of the Chairmen and members of the Committees named in Sections 2, 3, 4, 5, 6, 7 and 8, of this Article shall be appointed annually by nomination of the President and confirmation by the Board of Control. The Chairman shall sit in meetings of the Board of Control with full privilege of discussion. None of these Chairmen shall serve more than five years in succession.

SECTION 11. There shall be a General Policy Committee consisting of the President, the three preceding living Past Presidents; and one member representing the Water and Sewage Works Manufacturers Association. The member of the Committee representing the Water and Sewage Works Manufacturers Association shall be nominated by that Association's Board of Governors subject to acceptance by the Board of Control. The Chairman of the General Policy Committee shall be the immediate Past President of the Federation, who is, ex-officio, a member of the Board.

The General Policy Committee shall consider subjects referred to it by the Board, by the Executive Committee of the Board, or by the President; which subjects have to do with general or long-term policies of the Federation.

The recommendations or statements of policy formulated by the General Policy Committee upon any question referred to it, shall be reported to the Board for consideration and further action.

SECTION 12. There shall be a Committee on Nominations consisting of the five latest living Past Presidents, the senior member of which, in point of service, shall serve as Chairman.

SECTION 13. The Board shall appoint such other committees as may be necessary to carry on the work of the Federation.

SECTION 14. The reports and recommendations of all committees of the Federation shall be subject to approval by the Board.

SECTION 15. Members-at-Large are Active Members who are not members of the Board.

ARTICLE VII. Publications

All publications of the Federation shall be issued under the direction of the Board and shall be copyrighted as far as is practicable and proper.

ARTICLE VIII. Amendments

The Board of Control may amend these Bylaws in any manner not inconsistent with the Constitution by the two-thirds vote of those voting at any meeting of the Board or by sealed letter ballot, providing that a copy of such proposed amendment has been mailed by the Secretary to each member of the Board and to the Secretary of each Member Association at least thirty days prior to such meeting or letter ballot.

Federation of Sewage and Industrial Wastes Associations

Annual Year Book
and
Supplemental Directory

1959

OFFICERS

PAST PRESIDENTS

HONORS AND AWARDS

ANNUAL MEETINGS AND CONVENTIONS

DIRECTORY OF COMMITTEES

MEMBERSHIP SUMMARY

MEMBER ASSOCIATIONS

HONORARY MEMBERS

ASSOCIATE MEMBERS

SUPPLEMENTAL MEMBERSHIP DIRECTORY

FEDERATION OF SEWAGE AND INDUSTRIAL WASTES ASSOCIATIONS

4435 Wisconsin Avenue, N.W., Washington 16, D. C.

1958–59 OFFICERS

President: W. D. Hatfield

Vice-President: Mark D. Hollis

Treasurer: A. H. Niles

Executive Secretary-Editor: R. E. Fuhrman

Advisory Editor: F. W. Mohlman

PAST PRESIDENTS

*Charles A. Emerson.....1928–41	A. H. Niles.....1949–50
*Arthur S. Bedell.....1941–42	R. E. Fuhrman.....1950–51
George J. Schroepfer.....1942–43	Earnest Boyce.....1951–52
A M Rawn.....1943–44	E. Sherman Chase.....1952–53
Albert E. Berry.....1944–45	Louis J. Fontenelli.....1953–54
*John K. Hoskins.....1945–46	David B. Lee.....1954–55
Francis S. Friel.....1946–47	George W. Martin.....1955–56
George S. Russell.....1947–48	Emil C. Jensen.....1956–57
V. M. Ehlers.....1948–49	Kenneth S. Watson.....1957–58

HONORS AND AWARDS

Honorary Members

The qualifications for Honorary membership in the Federation are set forth in Article II, Section 4 of the Bylaws. Honorary Members are elected upon recommendation of a committee comprising the President and four latest Past Presidents, the senior Past President as chairman, in accordance with a policy adopted by the Board of Control on October 23, 1943. Honorary Members elected to date are as follows:

*Charles Alvin Emerson.....1941	Karl Imhoff.....1953
*Arthur S. Bedell.....1942	Harold Warner Streeter.....1953
*Julius W. Bugbee.....1942	Albert Edward Berry.....1954
*Langdon Pearse.....1942	William Thomas Lockett.....1954
Charles Gilman Hyde.....1943	Gordon Maskew Fair.....1955
*Howard Eugene Moses.....1943	William H. Wisely.....1956
Floyd William Mohlman.....1944	Morris M. Cohn.....1957
Willem Rudolfs.....1945	V. M. Ehlers.....1957
William John Orchard.....1946	E. Sherman Chase.....1958
F. Wellington Gilcreas.....1948	George J. Schroepfer.....1958
Wilford Willis DeBerard.....1950	

The Harrison Prescott Eddy Medal

The Harrison Prescott Eddy Medal is awarded annually to a member of any Member Association of the Federation for outstanding research contributing in important degree to the existing knowledge of the fundamental principles or processes of sewage treatment, as comprehensively described and published during any stated year in SEWAGE AND INDUSTRIAL WASTES. The award commemorates Harrison Prescott Eddy, a famous engineer and a pioneer in the art of sewage treatment.

* Deceased.

Past recipients of the award are:

Harry Willard Gehm.....1943
John Raymond Snell.....1944
Lloyd R. Setter.....1945
H. Heukelekian.....1946
Richard Pomeroy and
Fred D. Bowlus.....1947
F. W. Kittrell and
O. W. Kochtitzky, Jr.....1948
John W. Hood.....1949
Daniel A. Okun.....1950
Peter S. S. Dawson and
Samuel H. Jenkins.....1951
George S. Benton, John C. Geyer,
Wen-Hsiung Li, and Knut K.
Sorteberg 1952
Donald M. Pierce.....1953
William J. Oswald, Harold B.
Gotaas, Harvey F. Ludwig, and
Victoria Lynch.....1954
William J. Katz, William L. Lea,
and Gerard A. Rohlich.....1955
G. J. Schroepfer, W. J. Fullen,
A. S. Johnson, N. R. Ziemke,
and J. J. Anderson.....1956
W. N. Grune, J. V. Carter, Jr.,
and J. P. Keenan.....1957
W. E. Budd and
George F. Lambeth..... 1958

The George Bradley Gascoigne Medal

The George Bradley Gascoigne Medal is awarded annually to a member of any Member Association of the Federation for outstanding contribution to the art of sewage treatment works operation through the successful solution of important and complicated operational problems, as comprehensively described and published during any stated year in SEWAGE AND INDUSTRIAL WASTES. This award is in memory of George Bradley Gascoigne, a prominent consultant from 1922 to 1940, who demonstrated an unusual interest in matters of sewage works operation.

Past recipients of this award are:

Kerwin L. Mick.....1943
James T. Lynch and Uhl T. Mann...1944
John D. McDonald.....1945
LeRoy Winfield Van Kleeck.....1946
Leon S. Kraus.....1947
David P. Backmeyer.....1948
Wilbur N. Torpey.....1949
Clarence E. Keefer.....1950
Leonard S. Hillis.....1951
Walter Asa Sperry.....1952
W. N. Wells and Clarence H. Sherer 1953
Robert Ditmar Bargman.....1954
Abraham H. Chasick.....1955
Henry R. King.....1956
T. T. Hay.....1957
Dean M. Taylor.....1958

The Charles Alvin Emerson Medal

The Charles Alvin Emerson Medal is awarded annually to a member of any Member Association of the Federation "for outstanding service in the sewerage and sewage treatment works field, as related particularly to the problems and activities of the Federation of Sewage and Industrial Wastes Associations in such terms as the stimulation of membership, improving standards of operational accomplishments, fostering fundamental research, etc." This award honors Charles Alvin Emerson, who served as President of the Federation from 1928 to 1941 and became its first Honorary Member.

Past recipients are:

Floyd William Mohlman.....1943
Willem Rudolfs.....1944
Harold Warner Streeter.....1945
F. Wellington Gilcreas.....1946
*Langdon Pearse.....1947
LeRoy Winfield Van Kleeck.....1948
William J. Orchard.....1949
Morris M. Cohn.....1950
*Howard Eugene Moses.....1951
*Frank Woodbury Jones.....1952
William D. Hatfield.....1953
*Charles C. Ruchhoft.....1954
Merle Starr Nichols.....1955
E. Sherman Chase.....1956
Earnest Boyce.....1957
Gail P. Edwards.....1958

* Deceased.

The Industrial Wastes Medal

The Industrial Wastes Medal was established in 1949 to be awarded annually in the form of a plaque for the most outstanding contribution by an industrial employee on any aspect of industrial wastes control, as published in SEWAGE AND INDUSTRIAL WASTES during the year preceding the award.

Past recipients are:

Roy F. Weston, Robert G. Merman, and Joseph G. DeMann.....1950
Bruce W. Dickerson.....1951
Robert J. Austin, Roy N. Giles, C. T. Nicholson, and F. W. Scieneman 1952
Richard H. Coe.....1953
*N. H. Sanborn.....1954
Kenneth S. Watson.....1955
Charles R. Griffith.....1956
F. E. Dryden, P. A. Barrett, J. C. Kissinger, and W. W. Eckenfelder 1957
H. W. Bailkowski and P. S. Billington 1958

The Kenneth Allen Award

From 1943 through 1948, meritorious personal service to Member Associations was recognized by the Kenneth Allen Award. The award was retired in 1948.

Recipients of this award have been:

1943

Harry Thornton Calvert (ISP)
Edward F. Eldridge (Mich.)
*John Kurtz Hoskins (Fed.)
Fred Merryfield (Pac. N.W.)
Edward P. Molitor (N.J.)
Robert S. Phillips (N.C.)
Alfred Henry Weiters (Iowa)
William Homer Wisely (Cen. St.)

1944

Albert Edward Berry (Can.)
Van Porter Enloe (Ga.)
Albert Legrand Genter (Md.-Del.)
F. Wellington Gilcreas (N. Eng.)
Charles A. Holmquist (N.Y.)
Dana Ewart Kepner (Rky. Mtn.)
Leon Benedict Reynolds (Calif.)
Wilson Waldo Towne (Dak.)

1945

*Howard Eugene Moses (Pa.)
George S. Russell (Mo.)
Dario Travaini (Ariz.)
Frederick Holman Waring (Ohio)
Joe Williamson, Jr. (Fla.)
Murray Alderson Wilson (Kans.)

1946

E. J. M. Berg (Tex.)
Frank E. DeMartini (Fed.)
John R. Downes (N.J.)
Thomas J. Doyle (Mich.)
John Henry Garner (ISP)
Harold Benedict Gotaas (N.C.)
William P. Hughes (Pac. N.W.)
Theodore R. Lovell (Iowa)
George W. Martin (Cen. St.)

1947

William T. Knowlton (Calif.)
Floyd W. Pinney (Dak.)
Gilbert R. Frith (Ga.)
Clarence E. Keefer (Md.-Del.)
*Stuart E. Coburn (N. Eng.)
Wellington Donaldson (N.Y.)
Henry J. Darcey (Okla.)
Carroll H. Coberly (Rky. Mtn.)
William Storrie (Can.)
William Merriman Cobleigh (Mont.)

1948

George W. Marx (Ariz.)
David Bryon Lee (Fla.)
William Q. Kehr (Mo.)
F. Dean Stewart (Ohio)
Francis deSales Friel (Pa.)

* Deceased.

The Arthur Sidney Bedell Award

Established in 1948, the Arthur Sidney Bedell Award acknowledges extraordinary personal service to the Member Associations of the Federation. Each Member Association is privileged to name one of its members to receive the award, which may be earned by organizational leadership, administrative service, membership activity, stimulation of technical functions, or similar participation. The frequency of nomination varies from annually to once in three years, depending on membership. The award is named for the second President of the Federation, who exemplified its purpose by his long devotion and contribution to the affairs of the New York State Sewage Works Association (now the New York Sewage and Industrial Wastes Association).

Past recipients follow:

1949

Harry P. Croft (N.J.)
Victor Marcus Ehlers (Tex.)
*R. Paul Farrell (Ky.-Tenn.)
Carl Edwin Green (Pac. N.W.)
Frederick Leon McDonald (Ark.)
William Thomas Lockett (ISP)
*William McKinney Piatt (N.C.)
Walter Asa Sperry (Cen. St.)
Harold Warner Streeter (Fed.)
John L. Strelow (Iowa)

1950

Leland Bradney (Dak.)
John Chester Brigham (N.Y.)
Herbert B. Foote (Mont.)
*L. L. Hedgepeth (Va.)
Theodore J. Lafreniere (Can.)
Robert G. McCall (W. Va.)
Edward Alexander Reinke (Calif.)
Frank S. Taylor (Okla.)
LeRoy Winfield Van Kleeck (N. Eng.)
William Hugh Weir (Ga.)
Leonard Oliver Williams, Jr. (Rky. Mtn.)
Abel Wolman (Md.-Del.)

1951

Roy Binder (Kans.)
John Clinton Clark (Ala.)
*John Raymund Hoffert (Pa.)
John Robertson Hoy (Fla.)
Arthur H. Niles (Ohio)
Charles Henry Trusler (ISE)
Harold W. Yost (Ariz.)
Francis M. Veatch (Mo.)

1952

Don E. Bloodgood (Cen. St.)
Herman Glenn Baity (N.C.)
Paul Bolton (Iowa)
P. N. Daniels (N.J.)
Francis W. Kittrell (Ky.-Tenn.)
Ray E. Koon (Pac. N.W.)
Winfred S. Mahlie (Tex.)
Clarence Theodore Mudgett (Mich.)
Walter F. Freeborn (ISP)
Harrison Hale (Ark.)
George Ashby Rhame (S.C.)

1953

Robert James Auld (P.R.)
Charles G. Caldwell (Rky. Mtn.)
Nathan M. deJarnette (Ga.)
Anthony J. Fischer (N.Y.)
Ralph E. Fuhrman (Md.-Del.)
Quintin B. Graves (Okla.)
John B. Kleven (Dak.)
Douglas L. McLean (Can.)
Walter E. Merrill (N. Eng.)
Fred F. Palmer (Mont.)
Eugene C. Meredith (Va.)
Henry W. Speiden (W. Va.)
Arthur T. Wintersgill (Calif.)

* Deceased.

1954

Arthur N. Beck (Ala.)
Merle V. Ellis (Ariz.)
John W. Wakefield (Fla.)
Max Prüss (Germany)
Gilbert T. Cotterell (ISE)
Leland A. Talbot (Kans.)
*Charles A. Haskins (Mo.)
Theodore C. Schaetzle (Ohio)
Bernard S. Bush (Pa.)
Arnold Hoerler (Swiss)

1955

C. H. French (Ark.)
Frederick G. Nelson (Calif.)
George J. Schroepfer (Cen. St.)
Carl E. Schwob (Fed.)
Leo Holtkamp (Iowa)
F. T. Hambleton (ISP)
Herman D. Regan (Ky.-Tenn.)
James L. Love (La.)
Thomas J. Powers (Mich.)
William F. Rapp (Nebr.)
Henry Van Der Vliet (N.J.)
R. C. Sweeney (N.Y.)
P. D. Davis (N.C.)
Emil C. Jensen (Pac. N.W.)
T. R. Haseltine (Pa.)
W. T. Linton (S.C.)
Nils Westberg (Sweden)
J. H. Sorrels (Tex.)

1956

Arthur G. Pickett (Calif.)
Ray J. Desmarais (Can.)
W. W. Mathews (Cen. St.)
John E. Kiker, Jr. (Fla.)
Bruce M. McDill (Ohio)
Luis Ramos Robles (P.R.)
William J. Bishop (Okla.)
W. McLean Bingley (Md.-Del.)
Charles E. Drummond, Jr. (Ga.)
Rodney Preator (Mont.)
Steven M. Hurley, Jr. (N. Eng.)
Earl Devendorf (N.Y.)
C. H. Young (Pa.)
Harry K. Gidley (W. Va.)
Richard Messer (Va.)

1957

Joseph L. Crockett (Ala.)
Leigh Owen Gardner (Ariz.)
Alvin A. Appel (Calif.)
Gordon Henry Baker (Can.)
O. J. Muegge (Cen. St.)
David B. Smith (Fla.)
Friedrich Wilhelm Sierp (Germany)
Myron K. Nelson (Kans.)
Robert A. Greene (Mich.)
Lindon J. Murphy (Mo.)
Henry F. Munroe (N. Eng.)
Louis J. Fontenelli (N.J.)
*Raymond W. Hess (N.Y.)
Carl D. McGuire (Ohio)
Robert O. Sylvester (Pac. N.W.)
Howard T. Reuning (Pa.)

1958

F. W. Allen (ISP)
Clarence S. Anderson (Can.)
Ralph H. Baker, Jr. (Fla.)
S. Leary Jones (Ky.-Tenn.)
C. C. Larson (Cen. St.)
Victor J. Lechtenberg (Nebr.)
Elof Ljungholm (Sweden)
Uhl T. Mann (N.Y.)
Roger Moehlman (Tex.)
C. W. Oxford (Ark.)
Donald M. Pierce (Mich.)
George S. Rawlins (N.C.)
Raymond R. Ribal (Calif.)
T. E. Robertson (S.C.)
Robert S. Shaw (N.J.)
H. S. Smith (Iowa)
Kenneth H. Spies (Pac. N.W.)
A. J. Szabo (La.)
Roy F. Weston (Pa.)

* Deceased.

The William D. Hatfield Award

For the years 1946 through 1954, the William D. Hatfield Award recognized outstanding annual sewage works operation reports. After the first year, awards were made on the basis of plants serving (I) less than 10,000 population, (II) populations of 10,000 to 100,000, and (III) populations of more than 100,000.

This award was revised so that since 1956 it has been given for outstanding works operation. At that time, the frequency of this nomination was changed to correspond with the Bedell Award which is given each year, alternate years, or each third year, depending on the number of members within the Member Association.

Recipients of this award have been:

1946

Walter M. Kunsch

1947

F. E. Peterson (I)
John R. Szymanski (II)
Warren H. Sleeger and George J. Schroepfer (III)

1948

F. E. Peterson (I)
Thomas T. Hay (II)
Kerwin L. Mick (III)

1949

Russell D. Craun (I)
George W. Martin (II)
Thomas T. Hay (II)

1950

William L. Edwards (I)
Walter A. Sperry (II)
John R. Szymanski (II)
John W. Johnson (III)

1951

William L. Edwards (I)
J. E. Meers (II)
John R. Szymanski (II)
George H. Craemer (III)
Kerwin L. Mick (III)

1952–3; no award.

1954

Uhl T. Mann (II)
J. E. Meers (II)
C. W. Christenson (Indus.)

1955; no award.

1956

Murray B. McKinnie (Calif.)
I. G. Knoebel (Cen. St.)
F. W. Crane (N.Y.)
Arthur D. Caster (Ohio)
Curtis L. Glenn (Okla.)
Robert Bolenius (Pa.)
A. F. Chamblin (Va.)
George F. Craemer (N. Eng.)
Robert E. Simon (Fla.)
Gordon Remsburg (Md.-Del.)

1957

Owen D. Waldrep (Ala.)
Edward E. Bayze (Ariz.)
Edward O. Sampson (Calif.)
Douglas J. Davidson (Can.)
Ronald A. Kronewitter (Cen. St.)
Clifford M. Courson (Fla.)
Lyle Cunningham (Kans.)
J. C. Marshall (Mich.)
Walter C. Anderson (N. Eng.)
Anthony J. Maeri (N.J.)
Uhl T. Mann (N.Y.)
Andrew J. Wahl (Pac. N.W.)
King H. Hendrickson (Pa.)

1958

S. L. Allison (Tex.)
Carl Alm (Sweden)
William S. Applegate (N.J.)
Walter T. Blackman, Sr. (Ky.-Tenn.)
Loren Brannen (Nebr.)
John L. Brown (N.C.)
Frank M. Gibson (S.C.)
Charles Hicks (Can.)
Melvin F. Klemmick (Calif.)
John O. Laird (N.Y.)
Paul N. Longley (Pa.)
Kenneth E. Mathews (Pac. N.W.)
Kerwin L. Mick (Cen. St.)
Dan Millender (Ark.)
Stanley J. Mogelnicki (Mich.)
M. F. Neuzil (Iowa)
Daniel J. Raye (Fla.)

Membership Prizes

Prizes for membership activity in its various Member Associations have been awarded by the Federation since 1943. The numerical prize is given to the Member Association having the greatest numerical increase in membership during the year ending September 30 of the award year. The percentage prize is given for the greatest percentage increase in membership during the same period. The following Member Associations have received these prizes:

	Association			*Association*	
Year	*Num.*	*%*	*Year*	*Num.*	*%*
1943	Cen. St.	Fed.	1951	Mich.	ISE
1944	Cen. St.	Mo.	1952	Cen. St.	Fla.
1945	Can.	Ariz.	1953	Calif.	P. R.
1946	Can.	Okla.	1954	Pa.	P. R.
1947	ISP	Ark.	1955	Mich.	Ga.
1948	Pa.	W. Va.	1956	Cen. St.	Ky.-Tenn.
1949	Ohio	Ala.	1957	Fla.	Rky. Mtn.
1950	Iowa	La.	1958	Mich.	P. R.

The Quarter Century Operators' Club

The Quarter Century Operators' Club is an informal group comprising Active or Corporate Members of any Member Association who had been engaged in sewage treatment works operation, on a full-time resident basis, twenty-five years prior to the date of their admission into the Club. The Club was created in 1941 under the sponsorship of Frank Woodbury Jones, who served as its first registrar. The present registrar is Henry Van Der Vliet.

Philip Artese
Harry M. Beaumont
Don E. Bloodgood
Floyd G. Browne
Raymond G. Case
E. Sherman Chase
Morris M. Cohn
John W. Collom
Rodney E. Cook
P. N. Daniels
Nicholas De Haas, Sr.
Earl Devendorf
Joel Clifford Dillard
M. S. Fitzsimmons
George E. Flower
Harry M. Freeburn
E. D. Fry
G. L. Fugate
Ralph E. Fuhrman
Arnold H. Goodman
Michael A. Groen
William P. Gyatt
Wm. C. Hamm
Herbert W. Hansen
George I. Hanson
T. R. Haseltine
William D. Hatfield
Harry J. Krum
Roy S. Lanphear
Carl C. Larson
Harry C. Lewis
John V. Lewis
George S. Long
Winfield S. Mahlie
C. D. McGuire
Edwin C. McKeeman
E. F. Miltner
C. T. Mudgett
E. L. Nance
I. H. Nevitt
Arthur H. Niles
Andrew Palmer
John R. Palmer
Wm. A. Ryan
Theodore C. Schaetzle
Glenn Searls
Willard R. Smith
Walter A. Sperry
H. W. Streeter
John Struss
Myron W. Tatlock
S. L. Tolman
John C. Truax
Henry Van Der Vliet
Edwin B. Wagner
Oscar Ward
Charles E. Wheeler, Jr.

ANNUAL MEETINGS AND CONVENTIONS

No.	*Location*	*Date*	*No.*	*Location*	*Date*
1	Chicago, Ill.*	Oct. 16, 1928	16	Chicago, Ill.	Oct. 21–23, 1943
2	New York, N. Y.*	Jan. 18, 1929	17	Pittsburgh, Pa.	Oct. 12–14, 1944
3	New York, N. Y.*	Jan. 14, 1930	18	Chicago, Ill.*	Oct. 17–18, 1945
4	New York, N. Y.*	Jan. 22, 1931	19	Toronto, Ont., Can.	Oct. 7–9, 1946
5	New York, N. Y.*	Jan. 22, 1932	20	San Francisco, Calif.†	Jul. 21–24, 1947
6	New York, N. Y.*	Jan. 19, 1933		Philadelphia, Pa.*	Oct. 10, 1947
7	New York, N. Y.*	Jan. 18, 1934	21	Detroit, Mich.	Oct. 18–21, 1948
8	New York, N. Y.*	Jan. 18, 1935	22	Boston, Mass.	Oct. 17–20, 1949
9	New York, N. Y.*	Jan. 16, 1936	23	Washington, D. C.	Oct. 9–12, 1950
10	New York, N. Y.*	Jan. 22, 1937	24	St. Paul, Minn.	Oct. 8–11, 1951
11	New York, N. Y.*	Jan. 21, 1938	25	New York, N. Y.	Oct. 6–9, 1952
12	New York, N. Y.*	Jan. 20, 1939	26	Miami, Fla.	Oct. 13–16, 1953
13	New York, N. Y.*	Jan. 18, 1940	27	Cincinnati, Ohio	Oct. 11–14, 1954
	Chicago, Ill.†	Oct. 3–5, 1940	28	Atlantic City, N. J.	Oct. 10–13, 1955
14	New York, N. Y.*	Jan. 15, 1941	29	Los Angeles, Calif.	Oct. 8–11, 1956
	New York, N. Y.†	Oct. 9–11, 1941	30	Boston, Mass.	Oct. 7–10, 1957
15	Cleveland, Ohio	Oct. 22–24, 1942	31	Detroit, Mich.	Oct. 6–9, 1958

* Annual business meeting of Board of Control only.
† Convention of membership-at-large only.

DIRECTORY OF COMMITTEES

1958–59

CONSTITUTIONAL COMMITTEES

(*See Article VI of Bylaws*)

Executive Committee of the Board of Control

W. D. Hatfield, *Chairman*

M. D. Hollis, *Vice-Chairman*

W. W. Gillespie
G. E. Hauer
H. S. Kline
H. L. Thompson
K. S. Watson

Publications and Program Committee

The Publications and Program Committee arranges the technical programs for the annual conventions of the Federation and has general supervision of all publications of the Federation.

George E. Symons, *Chairman*

Paul Haney, *Vice-Chairman*

C. S. Anderson
H. H. Black
R. E. Fuhrman
E. F. Gloyna
J. B. Hanlon
E. Hurwitz
R. S. Ingols
H. S. Kline
D. B. Lee
L. F. Oeming
E. A. Pearson
W. W. Saxton
D. F. Smallhorst
K. S. Watson
R. F. Weston

Organization Committee

The Organization Committee examines and reports to the Board on applications for membership in the Federation and endeavors to encourage the formation of new regional associations or conferences eligible for membership.

J. W. Wakefield, *Chairman*

B. A. Poole, *Vice-Chairman*

Grant Howell W. Q. Kehr W. W. Saxton

Sewage and Industrial Wastes Practice Committee

The Sewage and Industrial Wastes Practice Committee reviews and directs for publication any resolution, report, or publication which establishes professional or technical standards in the name of the Federation. The following Manuals of Practice have been published under the direction of the committee:

No. 1—Safety in Wastewater Works (1959)
No. 2—Utilization of Sewage Sludge as Fertilizer (1946)
No. 3—Municipal Sewer Ordinances (1949, Reprinted 1957)
No. 4—Chlorination of Sewage and Industrial Wastes (1951)
No. 5—Air Diffusion in Sewage Works (1952)
No. 6—Units of Expression for Wastes and Waste Treatment (1958)
No. 8—Sewage Treatment Plant Design (1959)

Morris M. Cohn, *Chairman*

D. E. Bloodgood, *Vice-Chairman*

R. D. Bargman
T. W. Clapham
E. A. Farmer
R. E. Fuhrman
R. W. Haywood
M. S. Hilbert
E. R. Howard
C. E. Keefer
F. W. Mohlman
A. H. Niles
H. E. Orford
D. M. Pierce
M. L. Robins
H. S. Smith
L. W. Van Kleeck
F. M. Veatch
J. J. Wirts

Subcommittee on Sewer Maintenance

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been directed to develop a Manual of Practice on "Maintenance of Sewers and Appurtenant Structures." The first draft of the manual is in preparation.

T. W. Clapham, *Chairman*

A. A. Appel, *Vice-Chairman*

N. S. Bubbis
H. J. Graeser
J. L. Klamm
M. B. Nixon
G. M. Olewiler
Sydney Preen
C. S. Seabrook
L. E. West

Subcommittee on Standardization of Units

This subcommittee of the Sewage and Industrial Wastes Practice Committee has been assigned to develop an approved schedule of units to be used in the reporting of plant operation and laboratory data. A committee of about forty members is engaged in revising a preliminary draft.

H. E. Orford, *Chairman*

Sewage and Industrial Wastes Practice Committee (Cont.)

Subcommittee on Trickling Filters

This subcommittee of the Sewage and Industrial Wastes Practice Committee is engaged in the development of a Manual of Practice to be entitled "Trickling Filters—Their Characteristics and Loadings."

H. S. Smith, *Chairman*

B. F. Hatch
Kenneth V. Hill
H. F. Seidel
Wm. E. Stanley

Subcommittee on Paints and Protective Coatings

This subcommittee has the function of assembling experience and data on paints and protective coatings used in sewage works, to be presented with recommendations in the form of a manual. The subcommittee was created in 1946 and the first draft of the manual is now being prepared for critical review.

M. L. Robins, *Chairman*

Virgil Anderson
J. W. Johnson
L. S. Kraus
K. L. Mick
F. W. Pinney
Walter A. Sperry

Subcommittee on Vacuum Filtration of Sludge

This subcommittee was created in 1951 for the purpose of developing a Manual of Practice on vacuum filtration of sewage sludge.

E. R. Howard, *Chairman*

E. B. Cobb
J. D. McDonald
W. E. Stanley
L. W. Van Kleeck

Subcommittee on Operation of Sewage Plants

This subcommittee was created in 1953 for the purpose of developing a Manual of Practice on sewage plant operation.

D. M. Pierce, *Chairman*

A. P. Troemper, *Vice-Chairman*

Ben Benas
W. M. Bingley
D. E. Bloodgood
P. N. Daniels
E. F. Eldridge
R. E. Fuhrman
G. E. Griffin
L. S. Kraus
W. S. Mahlie
A. H. Niles
H. G. Rogers
C. I. Sterling, Jr.
G. E. Symons
L. W. Van Kleeck

Industrial Wastes Manual Subcommittee

This subcommittee was created in 1957 to review the availability of manuals from all sources concerning the treatment of industrial wastes and to determine the need for additional manuals, if any, that should be prepared by the Federation.

R. W. Haywood, *Chairman*

J. E. Barker
E. B. Besselievre
Walter Carroll
C. W. Hathaway
V. D. Lukas
G. M. Neas

Sewage and Industrial Wastes Practice Committee (Cont.)

Sewage Works Finance Subcommittee

This subcommittee was created in 1957 to study the need for a manual on Sewage Works Financing.

E. A. Farmer, *Chairman*

A. A. Estrada — Roy Ritter — Kenneth Spies
Paul Haney — S. I. Zack

Subcommittee on Sewage Treatment Plant Design

The following Federation representatives were appointed in 1953 to serve jointly with representatives of the American Society of Civil Engineers in the production of a Manual of Practice.

T. R. Haseltine — M. H. Klegerman — G. W. Martin
G. E. Hubbell — F. D. Wraight

Subcommittee on Storm and Sanitary Sewer Design

The following Federation representatives were appointed in 1953 to serve jointly with representatives of the American Society of Civil Engineers in the production of a Manual of Practice.

C. G. Gaither — L. L. Sphar — C. R. Velzy
H. S. Smith — S. I. Zack

Subcommittee on the Revision of Federation Manual of Practice No. 3

A. H. Niles, *Chairman*

A. D. Caster — R. S. Phillips — D. F. Smallhorst

Subcommittee on Sludge Digestion

This subcommittee was created in 1958 to prepare a Manual of Practice on Sludge Digestion as applied to wastewater treatment.

R. D. Bargman, *Chairman*

C. B. Carpenter — R. R. Kennedy — E. S. Ordway
W. N. Grune — M. F. Neuzil — R. H. Ritter
R. H. Howe — W. A. O'Leary — J. W. Townsend

Subcommittee on Fringe Area Sanitation

This subcommittee was created in 1958 to study and prepare a Manual of Practice on wastewater collection and disposal problems of residential and commercial development in fringe areas of communities.

M. S. Hilbert, *Chairman*

C. F. Abel — M. C. Hope — E. H. Olsen
S. A. Berkowitz — R. J. Johnson — E. L. Stockton
H. F. Ludwig

Research Committee

The Research Committee has the function of stimulating research work among the various Member Associations, and of cooperating with other organizations in the promotion of research. The Committee makes an annual review of the literature on sewage, waste treatment, and water pollution.

H. Heukelekian, *Chairman*

R. Manganelli, *Vice-Chairman*

H. Amberg
E. J. Berg
H. F. Clark
C. H. Connell
W. E. Dobbins
G. Edwards
M. B. Ettinger
D. G. Foulke
T. D. Furman
I. Gellman
H. G. Harding
R. D. Hoak
R. S. Ingols
W. M. Ingram
P. W. Kabler
M. Katz
F. W. Kittrell
H. G. Luley
P. H. McGauhey
W. A. Moore
R. Porges
E. R. Roth
A. J. Steffen
C. Straub
C. M. Tarzwell
G. H. Teletzke
W. W. Towne
H. A. Trebler
E. C. Tsivoglou
E. Weisberg
R. L. Woodward

Finance Committee

The Finance Committee develops the annual operating budget of the Federation and affords guidance to the Board of Control in financial affairs.

W. J. Orchard, *Chairman*

H. E. Schlenz, *Vice-Chairman*

W. D. Hatfield
A. H. Niles
K. S. Watson

Committee on Standard Methods of Sewage and Industrial Wastes Analysis

Created by the Board of Control on January 22, 1931, the Committee on Standard Methods of Analysis was given constitutional status in October 1953. The committee develops, perfects, and modifies standard methods for the analysis of sewage and industrial wastes and of sludges or by-products therefrom. It also functions with similar committees of the American Water Works Association and American Public Health Association in the production of the laboratory manual *Standard Methods for the Examination of Water and Sewage,* the tenth edition of which was published early in 1955.

G. P. Edwards, *Chairman*

R. S. Ingols, *Vice-Chairman*

C. A. Bishop
D. E. Bloodgood
A. M. Buswell
C. J. Carney
N. S. Chamberlin
J. M. Cohen
M. Dannis
R. V. Day
K. Frashina
C. F. Gurnham
W. D. Hatfield
W. L. Henderson
H. Heukelekian
R. D. Hoak
E. F. Hurwitz
E. L. Jones
R. J. Karpen
R. J. Keating
J. E. Kinney
R. R. Kountz
J. B. Lackey
J. C. Lamb
G. W. Lawton
K. M. Mackenthun
H. C. Marks
M. G. Mellon
W. A. Moore
G. B. Morgan
J. C. Morris
F. E. Nussberger
T. R. Ostrom
R. Pomeroy
M. L. Robins
G. A. Rohlich
W. W. Sanderson
C. N. Sawyer
L. R. Setter
O. C. Sieverding
C. M. Tarzwell
R. F. Weston

Industrial Wastes Committee

The Industrial Wastes Committee was created by the Board of Control on October 23, 1943, for the purpose of developing interest in this important field and to direct a program whereby the Federation may be of service in industrial waste problems.

K. S. Watson, *Chairman*

H. T. Reuning, *Vice-Chairman*

V. W. Bacon
E. B. Besselievre
H. H. Black
D. E. Bloodgood
J. L. Brown
J. F. Byrd
G. Chanin
H. F. Elkin
C. Fair
W. J. Fullen
Harry Gehm
C. F. Gurnham
Kerry Mills
S. J. Mogelnicki
L. F. Oeming
G. A. Pettit
R. F. Rocheleau
R. E. Rostenbach
C. N. Sawyer
A. J. Steffen
R. F. Weston

General Policy Committee

K. S. Watson, *Chairman*

E. C. Jensen, *Vice-Chairman*

J. J. Gilbert
W. D. Hatfield
G. W. Martin

Committee on Nominations

The special Nominating Committee was created by the Board of Control on October 9, 1946, to function in an advisory capacity to the Election Committee. The Nominating Committee is to comprise the last five living Past Presidents, with the senior Past President as chairman.

L. J. Fontenelli, *Chairman*

D. B. Lee, *Vice-Chairman*

E. C. Jensen
G. W. Martin
K. S. Watson

SPECIAL COMMITTEES

Committee on Personnel Advancement

Authorized by the Board of Control on October 11, 1941, this Committee is assigned to "establish minimal qualifications for operators of various classes of treatment works." The committee also has the duty of collecting and compiling data on present procedures in the licensing and certification of operators for reference to Member Associations.

Sol Seid, *Chairman*

M. E. Dawkins, *Vice-Chairman*

W. T. Ballard
Benjamin Benas
J. E. Cooper
Ernest Hamilton
W. A. Hasfurther
C. W. Klassen
William Larkin
George Lohmeyer
M. Neuzil
D. M. Pierce
T. C. Schaetzle
H. S. Smith

Awards Committee

A. G. Pickett, *Chairman*

Subcommittee on Eddy Award

H. F. Ludwig, *Chairman*

J. G. Geyer W. J. Katz

Subcommittee on Gascoigne Award

L. S. Kraus, *Chairman*

D. P. Backmeyer W. A. Sperry

Subcommittee on Emerson Award

L. W. Van Kleeck, *Chairman*

E. Sherman Chase M. S. Nichols

Subcommittee on Industrial Wastes Award

Bruce Dickerson, *Chairman*

W. W. Eckenfelder W. R. Taylor

Honorary Membership Committee

Authorized by the Board of Control on October 24, 1942, this committee is comprised of the President and four latest, living Past Presidents with the senior Past President as chairman. The committee reviews nominations for election to the grade of Honorary Member and makes recommendations to the Board on such nominations.

D. B. Lee, *Chairman*

W. D. Hatfield G. W. Martin
E. C. Jensen K. S. Watson

Legislative Analysis Committee

The Legislative Analysis Committee was created by the Board of Control on October 17, 1945, to study legislation pertinent to the interests of the Federation and to serve the Board in advisory capacity.

D. B. Lee, *Chairman*

V. W. Bacon C. M. Everts D. F. Smallhorst
P. W. Eastman R. K. Horton C. R. Walbridge
R. S. Shaw

Quarter Century Operators' Club Committee

The special Quarter Century Operators' Club Committee was created by the Board of Control on October 9, 1946. It is the function of this Committee to establish eligibility requirements, process membership applications, maintain the roster, and supervise the activities of the Quarter Century Operators' Club.

H. Van Der Vliet, *Chairman*

A. H. Niles Harold W. Streeter

Constitution and Bylaws Committee

The Constitution and Bylaws Committee was created by the Board of Control on October 10, 1947, to review and develop recommendations for the amendment of the Constitution and Bylaws of the Federation as may be deemed advisable under changing conditions.

G. J. Schroepfer, *Chairman*

R. F. Weston, *Vice-Chairman*

E. Boyce
F. J. McKee
W. J. Orchard
M. L. Robins
W. H. Wisely

Safety Committee

This committee was created in 1954 for the purpose of maintaining close liaison between the Federation and the National Safety Council in the fields common to both organizations.

J. J. Wirts, *Chairman*

G. L. Burt
U. T. Mann
W. W. Mathews
H. A. Schreiber
W. N. Torpey
L. W. Van Kleeck

Public Relations Committee

This committee was created in 1957 to determine what activities could be undertaken in the field of stream pollution control and waste treatment, and to help the Federation to direct its activities accordingly.

A. C. Bryan, *Chairman*

C. J. Durham, *Vice-Chairman*

C. H. Billings
A. W. Busch
C. M. Everts, Jr.
P. D. Haney
G. A. Rohlich
H. E. Schlenz
J. C. Seeger, Jr.
E. S. Tisdale
K. S. Watson

Nuclear Wastes Committee

This committee was created in 1957 to study the responsibility of the Federation in this role and recommend activities in harmony with the Federation's objectives.

J. M. Smith, Jr., *Chairman*

R. E. Foster
E. F. Gloyna
W. Grune
W. J. Kaufman
J. A. Lieberman
B. A. Poole
C. P. Straub

Name Change Committee

This committee was created by the Board of Control on October 9, 1958 to consider the desirability of an organizational name change and to recommend such change if considered appropriate.

R. F. Weston, *Chairman*

A. E. Berry
E. S. Chase
J. E. Cooper
R. E. Fuhrman
E. C. Jensen
F. H. Miller
G. E. Symons

Resolutions Committee

The Resolutions Committee was created by the Board of Control on October 9, 1958. Its function is to recommend to the Board of Control appropriate resolutions.

A. C. Bryan, *Chairman*

C. H. Billings W. L. Powell

JOINT COMMITTEES WITH OTHER ORGANIZATIONS

(Also see Sewage and Industrial Wastes Practice Committee)

Federation Representatives, ASEIB

This committee was authorized by the Board of Control to represent the Federation on the American Sanitary Engineering Intersociety Board. The objectives of this Board include recognition of sanitary engineers through formal certification.

FSIWA Representatives

R. E. Lawrence D. F. Metzler R. S. Rankin

Joint Committee on Chlorine Supply

On October 11, 1951, the Board of Control authorized participation in the Joint Committee on Chlorine Supply with the American Water Works Association and the Conference of State Sanitary Engineers. The objective of the committee is to study problems of chlorine supply and distribution in the water and sewage fields, and to develop recommendations for their solution.

FSIWA Representatives

H. A. Faber W. E. Gerdel

Joint Policy Committee

This joint committee was created in 1954 to provide a unified approach to problems or actions arising by reasons of emergencies or in the common interest. Representation on the committee is held by the Federation, the American Water Works Association, and the Water and Sewage Works Manufacturers' Association.

FSIWA Representatives

R. E. Fuhrman E. C. Jensen W. J. Orchard
W. D. Hatfield G. W. Martin K. S. Watson

ASTM Committee D-19

G. P. Edwards R. S. Ingols

Joint Committee for Uniformity of Methods for Water Examination

G. P. Edwards R. S. Ingols

SPECIAL CONVENTION COMMITTEES

Convention Management Committee

The function of this committee is to supervise details of the management of the Annual Meetings of the Federation.

H. E. Schlenz, *Chairman*

A. C. Bryan
B. S. Bush
R. E. Fuhrman
J. G. Stewart

Meeting Place Committee

This committee reviews invitations received for the Annual Meetings of the Federation and makes recommendations to the Board of Control in regard to the time and place of such meetings.

W. D. Hatfield, *Chairman*

E. E. Alt
R. V. Ford
R. E. Fuhrman
M. D. Hollis
J. G. Stewart
K. S. Watson

MEMBERSHIP SUMMARY

(*As of December 31, 1958*)

Federation Members

Honorary Members	16
Associate Members	78
Member Associations	43
Active Members	8,110
Corporate Members	197

Net Membership of Member Associations

Member Association	Active	Honorary	Corporate	Total
Alabama	56	—	—	56
Arizona	39	—	4	43
Arkansas	45	—	1	46
California	637	1	5	643
Canada	616	1	—	617
Central States *	711	4	29	744
Dakota-North	15	—	—	15
Dakota-South	33	—	—	33
Federal	86	1	—	87
Florida	457	—	—	457
Georgia	91	—	1	92
Germany	40	1	—	41
Iowa	129	—	1	130
IPHE-England	25	—	—	25
ISP-England	128	1	—	129
Israel	20	—	—	20
Kansas	180	—	1	181
Kentucky-Tennessee	199	—	6	205
Louisiana	15	—	—	15
Maryland-Delaware	69	—	5	74
Michigan	581	—	2	583
Mississippi	71	—	3	74
Missouri	66	—	—	66
Montana	31	—	4	35
Nebraska	61	—	—	61
New England	407	3	—	410
New Jersey	320	1	2	323
New York	627	2	22	651
New Zealand	30	—	—	30
North Carolina	167	—	36	167
Ohio	405	—	—	441
Oklahoma	45	—	3	45
Pacific Northwest	351	—	29	354
Pennsylvania	478	—	—	507
Puerto Rico	96	—	4	96
Rocky Mountain	117	—	2	121
South Carolina	45	—	—	47
Sweden	111	—	—	111
Swiss	17	1	4	17
Texas	257	—	1	262
Utah	39	—	16	40
Virginia	123	—	16	139
West Virginia	74	—	—	90
Totals	8,110	16	197	8,323

* Indiana Sewage and Industrial Wastes Association admitted to membership November 1, 1958. Memberships in the Association became effective January 1, 1959.

MEMBER ASSOCIATIONS

Alabama Water and Sewage Association—Sewage Works Section (Affiliated 1948).

Territory: State of Alabama.
President: D. R. McLemore; *Vice-President:* A. F. Lankford; *Director:* T. Jaffe; *Treasurer:* H. R. Thacker; *Secretary:* E. J. Finnell, Jr., University of Alabama, University, Ala.

Arizona Sewage and Water Works Association—Sewage Works Section (Affiliated 1928).

Territory: State of Arizona.
President: A. L. Frick; *First Vice-President:* H. C. Bigglestone; *Second Vice-President:* R. E. Polenske; *Director:* E. O. Dye; *Secretary-Treasurer:* Stanford I. Roth, 813 Jefferson St., Phoenix, Ariz.

Arkansas Water and Sewage Conference—Sewage Works Section (Affiliated 1946).

Territory: State of Arkansas.
Chairman: Nall Brantley; *Vice-Chairman:* Marion Ulmer; *Director:* M. L. Wood; *Secretary-Treasurer:* Dr. C. W. Oxford, Univ. of Arkansas, Fayetteville, Ark.

California Sewage and Industrial Wastes Association (Affiliated 1928).

Territory: State of California.
President: R. D. Bargman; *First Vice-President:* P. H. McGauhey; *Second Vice-President:* Dennis O'Leary; *Directors:* R. T. Antrim and H. Harvey Hunt; *Secretary-Treasurer:* Alfred D. Leipzig, 12000 Vista Del Mar, Venice, Calif.

Canadian Institute on Sewage and Sanitation (Affiliated 1933).

Territory: Dominion of Canada.
President: J. F. MacLaren; *Vice-President:* W. L. Wardrop; *Director:* C. G. Russell Armstrong; *Secretary-Treasurer:* A. E. Berry, Administrative Office, 72 Grenville St., Toronto 8, Ont., Can.

Central States Sewage and Industrial Wastes Association (Affiliated 1928).

Territory: States of Illinois, Wisconsin, and Minnesota.
President: R. W. Frazier; *First Vice-President:* L. H. Smith; *Second Vice-President:* W. A. Sperry; *Directors:* O. J. Muegge (election of second Director pending); *Secretary-Treasurer:* Scott A. Linsley, P. O. Box 3598, Childs Rd., St. Paul, Minn.

Dakota Water and Sewage Works Conference—Sewage Works Sections (Affiliated 1936).

North Dakota Section

Territory: State of North Dakota.
President: H. J. Arnold; *Vice-President:* Frank Orthmeyer; *Director:* Don C. Kalda; *Secretary-Treasurer:* W. Van Heuvelen, State Dept. of Health, Bismarck, N. Dak.

South Dakota Section

Territory: State of South Dakota.
President: A. Ross; *Vice-President:* Byron Fees; *Director:* Don C. Kalda; *Secretary-Treasurer:* Don C. Kalda, Div. of Sanitary Engineering, State Board of Health, Pierre, S. Dak.

Federal Sewage Research Association (Affiliated 1930).

Territory: Federal employees wherever stationed.
President: B. B. Berger; *Vice-President:* K. S. Krause; *Director:* G. E. McCallum; *Secretary-Treasurer:* Ralph Holtje, U.S.P.H.S., Rm. 4123, So. HEW Bldg., Washington 25, D. C.

Florida Sewage and Industrial Wastes Association (Affiliated 1941).

Territory: State of Florida.
President: S. A. Berkowitz; *Vice-President:* Clifford M. Courson; *Director:* J. W. Wakefield; *Secretary-Treasurer:* Arthur R. Finney, Jr., 4801 S.W. 117th Ave., Miami 55, Fla.

Georgia Water and Sewage Association—Sewage Works Section (Affiliated 1936).

Territory: State of Georgia.
President: A. B. Culverhouse; *First Vice-President:* I. C. Kelley; *Second Vice-President:* H. O. Whelchel, Jr.; *Director:* R. E. Stiemke; *Secretary-Treasurer:* A. T. Storey, 1210 Hemphill Ave., N.W., Atlanta, Ga.

German Sewage and Industrial Wastes Association (Affiliated 1950).
(Abwassertechnische Vereinigung)

Territory: Western Germany.
President: F. Schreier; *First Vice-President:* Dr. Ing. Schmitz-Lenders; *Second Vice-President:* Wilhelm Husmann; *Director:* Dr. Ing. Schmitz-Lenders; *Secretary-Treasurer:* O. Pallasch, Theaterstrasse 24, Bonn, Germany.

Indiana Sewage and Industrial Wastes Association (Affiliated 1958).

Territory: State of Indiana.
President: Paul Brunner; *First Vice-President:* Robert W. Heider; *Second Vice-President:* George K. Erganian; *Director:* W. W. Mathews; *Secretary-Treasurer:* Frank D. Wraight, State Dept. of Health, 1330 West Michigan St., Indianapolis 7, Ind.

Institute of Sewage Purification—England (Affiliated 1932).

Territory: British Empire.
President: W. H. Hillier; *First Vice-President:* B. A. Southgate; *Second Vice-President:* M. A. Kershaw; *Director:* M. Lovett; *Treasurer:* L. B. Phillipps; *Secretary:* W. F. A. Snook, 10 Cromwell Place, South Kensington, London, S. W. 7, England.

Institution of Public Health Engineers—England (Affiliated 1932).

Territory: British Empire.
President: J. T. Calvert; *Vice-President:* N. J. Tatman; *Director:* M. A. Kershaw; *Treasurer:* A. Sciver; *Secretary:* Ernest V. Balsom, 118 Victoria St., Westminster, S.W. 1, London, England.

Iowa Sewage and Industrial Wastes Association (Affiliated 1928).

Territory: State of Iowa.
President: R. Briley; *Vice-President:* D. D. Douglas; *Director:* H. F. Seidel; *Treasurer:* Harry Boren; *Secretary:* L. F. Skorczeski, 207 South 15th Ave., Marshalltown, Iowa.

Israel Association of Sewage Engineers (Affiliated 1957).

Territory: Israel.
President: Dr. Peter Yehuda; *Director:* Hillel Shuval; *Secretary:* Eliezer Balasha, Technion, Israel Institute of Technology, P. O. Box 4910, Haifa, Israel.

Kansas Sewage and Industrial Wastes Association (Affiliated 1935).

Territory: State of Kansas.
Chairman: S. W. Smith; *Vice-Chairman:* W. K. Moffatt; *Second Vice-Chairman:* C. L. Goble; *Director:* R. D. Lee; *Secretary-Treasurer:* James F. Aiken, 1900 E. 9th St., Wichita, Kans.

Kentucky-Tennessee Industrial Wastes and Sewage Works Association (Affiliated 1946).

Territory: States of Kentucky and Tennessee.
Chairman: C. G. Gaither; *Vice-Chairman:* A. L. Strub; *Director:* M. A. Churchill; *Secretary-Treasurer:* S. Leary Jones, 602 Cordell Hull Bldg., Nashville 3, Tenn.

Louisiana Conference on Water Supply and Sewerage—Sewage Works Section (Affiliated 1949).

Territory: State of Louisiana.
Chairman: P. G. Grambling; *Vice-Chairman:* A. J. Szabo; *Director:* H. J. Scioneaux; *Secretary-Treasurer:* George H. West, P. O. Box 15, Lake Charles, La.

Maryland-Delaware Water and Sewage Association—Sewage Works Section (Affiliated 1928).

Territory: States of Maryland and Delaware.
President: D. K. Harmeson; *First Vice-President:* Louis E. Otts; *Second Vice-President:* C. Gordon Remsburg; *Director:* H. A. Schreiber; *Secretary-Treasurer:* W. M. Bingley, 2411 N. Charles St., Baltimore 18, Md.

Michigan Sewage and Industrial Wastes Association (Affiliated 1930).

Territory: State of Michigan.
President: R. J. Peterson; *First Vice-President:* Reginald Aiken; *Second Vice-President:* James Graham; *Director:* George E. Hubbell; *Secretary-Treasurer:* D. M. Pierce, Michigan Dept. of Health, Room 331, Administration Bldg., Lansing 4, Mich.

Mississippi Sewage and Industrial Wastes Association (Affiliated 1957).

Territory: State of Mississippi.
President: J. E. Johnston; *Vice-President:* H. K. Williford; *Director:* G. M. Lester; *Secretary-Treasurer:* Neil G. McMahon, Mississippi State Board of Health, Jackson, Miss.

Missouri Water and Sewerage Conference—Sewage Works Section (Affiliated 1929).

Territory: State of Missouri.
Chairman: Werner Heidtke; *Vice-Chairman:* Lawrence Martin; *Director:* S. C. Smith; *Secretary-Treasurer:* Warren A. Kramer, c/o State Office Bldg., Room 400, Jefferson City, Mo.

Montana Sewage and Industrial Wastes Association (Affiliated 1944).

Territory: State of Montana.
Chairman: R. C. Fargo; *Vice-Chairman:* E. R. Waldo; *Director:* D. H. Denman; *Secretary-Treasurer:* A. W. Clarkson, Div. of Environ. Sanit., State Bd. of Health, Helena, Mont.

Nebraska Sewage and Industrial Wastes Association (Affiliated 1952).

Territory: State of Nebraska.
President: Harold Hoskins; *Vice-President:* Loren Brannen; *Director:* T. A. Filipi; *Secretary-Treasurer:* V. J. Lechtenberg, 2549 Farnum St., Omaha, Nebr.

New England Sewage and Industrial Wastes Association (Affiliated 1929).

Territory: States of Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island.
President: H. F. Munroe; *First Vice-President:* W. M. Kunsch; *Second Vice-President:* Joseph B. Hanlon; *Director:* T. R. Camp; *Secretary-Treasurer:* Earl R. Howard, 115 Broad St., Hartford 5, Conn.

New Jersey Sewage and Industrial Wastes Association (Affiliated 1942).

Territory: State of New Jersey.
President: A. Palmer; *First Vice-President:* R. J. Budrick; *Second Vice-President:* M. S. Kachorsky; *Director:* R. S. Shaw; *Treasurer:* H. Van Der Vliet; *Secretary:* Anthony T. Leahey, P. O. Box 32, West Trenton, N. J.

New York Sewage and Industrial Wastes Association (Affiliated 1930).

Territory: State of New York.
President: S. W. Steffenson; *Vice-President:* C. J. Bernhardt; *Directors:* C. E. Irving and Uhl T. Mann; *Treasurer:* D. B. Stevens; *Secretary:* R. C. Sweeney, c/o State Dept. of Health, 21 N. Broadway, White Plains, N. Y.

New Zealand Sewage and Industrial Wastes Association (Affiliated 1957).

Territory: New Zealand.
Chairman: P. R. Parr; *Vice-Chairman:* K. R. Davis; *Director:* A. S. Wallace; *Secretary:* Ronald Hicks, P. O. Box 208, Auckland, New Zealand.

North Carolina Sewage and Industrial Waste Association (Affiliated 1929).

Territory: State of North Carolina.
Chairman: W. E. Long, Jr.; *Vice-Chairman:* R. E. Ebert; *Director:* L. S. Dukes; *Secretary-Treasurer:* D. Y. Brannock, Utilities Director, City of Burlington, 1703 Woodland Ave., Burlington, N. C.

Ohio Sewage and Industrial Wastes Treatment Conference (Affiliated 1932).

Territory: State of Ohio.
Chairman: James E. Frook; *First Vice-Chairman:* E. W. Petrich; *Second Vice-Chairman:* A. D. Caster; *Director:* H. S. Kline; *Secretary-Treasurer:* Ward E. Conrad, Ohio Dept. of Health, 101 N. High St., Columbus 15, Ohio.

Oklahoma Water, Sewage and Industrial Waste Conference—Sewage Works Section (Affiliated 1929).

Territory: State of Oklahoma.
President: C. T. Grant; *Vice-President:* John Downing; *Director:* G. L. Morris; *Secretary-Treasurer:* H. M. Crane, State Dept. of Health, 3400 N. Eastern, Oklahoma City 5, Okla.

Pacific Northwest Sewage and Industrial Wastes Association (Affiliated 1933).

Territory: States of Washington, Oregon, and Idaho.
President: M. W. Runyan; *Vice-President:* Robert O. Sylvester; *Director:* H. L. Thompson; *Secretary-Treasurer:* Gilbert H. Dunstan, P. O. Box 176, Pullman, Wash.

Pennsylvania Sewage and Industrial Wastes Association (Affiliated 1928).

Territory: State of Pennsylvania.
President: H. W. McElhaney; *First Vice-President:* S. I. Zack; *Second Vice-President:* A. A. Estrada; *Directors:* T. R. Haseltine and B. S. Bush; *Secretary-Treasurer:* J. R. Harvey, Regional San. Engr., Pennsylvania Dept. of Health, 916 Diamond, Meadville, Pa.

Puerto Rico Water and Sewage Works Association (Affiliated 1947).

Territory: Puerto Rico.
President: Ramon Guzman; *Vice-President:* P. J. Rios Vargas; *Director:* R. Domenech; *Secretary-Treasurer:* Robert J. Auld, Espana 2015, Ocean Park, Santurce, Puerto Rico.

Rocky Mountain Sewage Works Association (Affiliated 1947).

Territory: States of Wyoming, Colorado, and New Mexico.
President: J. M. Hunter; *Vice-President:* B. V. Howe; *Director:* J. H. Maguire; *Secretary-Treasurer:* Verne E. Plath, P. O. Box 149, Englewood, Colo.

South Carolina Water and Sewage Works Association—Sewage Works Section (Affiliated 1949).

Territory: State of South Carolina.
Chairman: O. M. Fuller; *Vice-Chairman:* Carl C. Lanford; *Director:* J. D. Lesslie; *Secretary-Treasurer:* Robert N. Bowen, 417 Wade Hampton Office Bldg., Columbia, S. C.

Swedish Association for Water Hygiene (Affiliated 1952).
(Föreningen För Vattenhygien)

Territory: Sweden.
President: V. Jansa; *Vice-President:* L. Friberg; *Director:* G. Akerlindh; *Secretary:* Erik Jonsson, Box 5038, Stockholm 5, Sweden.

Swiss Association of Water and Sewage Professionals (Affiliated 1947).
(Verband Schweizerischer Abwasserfachleute)

Territory: Switzerland.
President: A. Horler; *Director:* A. Horler; *Treasurer:* E. Holinger; *Secretary:* P. Wildi, Hegemmatt 28, Zurich, Switzerland.

Texas Water and Sewage Works Association—Sewage and Industrial Wastes Section (Affiliated 1928).

Territory: State of Texas.
Chairman: R. Moehlman; *First Vice-Chairman:* T. L. Satterwhite; *Second Vice-Chairman:* C. H. Williams; *Director:* A. C. Bryan; *Secretary:* V. M. Ehlers, 2202 Indian Trail, Austin, Tex.; *Assistant Secretary and Treasurer:* Mrs. E. H. Goodwin.

Utah Sewage and Industrial Wastes Association (Affiliated 1957).

Territory: State of Utah.
President: Blaine Liston; *Vice-President:* Lyle Ford; *Director:* L. M. Thatcher; *Secretary:* Howard Hurst, 479 Harvard Ave., Salt Lake City 11, Utah.

Virginia Industrial Wastes and Sewage Works Association (Affiliated 1947).

Territory: State of Virginia.
President: E. H. Ruehl; *Vice-President:* A. H. Paessler; *Director:* F. H. Miller; *Secretary-Treasurer:* Orval J. Hand, Hercules Powder Co., Hopewell, Va.

West Virginia Sewage and Industrial Wastes Association (Affiliated 1947).

Territory: State of West Virginia.
President: H. W. Pitts; *First Vice-President:* R. C. Pierson; *Second Vice-President:* R. L. Williams; *Director:* O. C. Thompson; *Secretary-Treasurer:* Glen O. Fortney, State Dept. of Health, Charleston 5, W. Va.

HONORARY MEMBERS *

Berry, Albert E. (1954), Gen. Mgr., Ont. Water Res. Comm., 235 Gainsboro Rd., Toronto 8, Ont., Can. (Can.)

Chase, E. Sherman (1958), Cons. Engr., Partner, Metcalf and Eddy, 1300 Statler Bldg., Boston 16, Mass. (N. Eng.)

Cohn, Morris M. (1957), Editor, *Wastes Engineering*, 305 E. 45th St., New York 17, N. Y. (N.Y.)

DeBerard, Wilford Willis (1950), Dep. Commr. of Water and Chf. Water Engr., Bur. of Eng., Dept. of Pub. Works, 402 City Hall, Chicago 2, Ill. (Cen. St.)

Ehlers, Victor M. (1957), Chf. San. Engr., State Dept. of Health, 2616 Rio Grande, Austin, Tex. (Tex.)

Fair, Gordon Maskew (1955), Head, Dept. of San. Eng., Harvard Univ., 935 Memorial Dr., Cambridge 38, Mass. (N. Eng.)

Gilcreas, F. Wellington (1948), Prof. of San. Sc., Univ. of Fla., Gainesville, Fla. (N. Eng.)

Hyde, Charles Gilman (1943), Cons. Engr., 2599 Buena Vista Way, Berkeley 8, Calif. (Calif.)

Imhoff, Karl (1953), Cons. Engr., Robert Schmidt Str. 8, Essen, Germany (Germany)

Lockett, William T. (1954), Chf. Chemist, Mogden Purification Works, Oak Lane, Isleworth, Middlesex, Eng. (ISP)

Mohlman, Dr. Floyd W. (1944), Dir., Div. of Lab., Met. San. Dist. of Greater Chicago, 100 E. Erie St., Rm. 301, Chicago 11, Ill. (Cen. St.)

Orchard, William J. (1946), Wallace & Tiernan Co., Inc., Newark 1, N. J. (N.Y.)

Rudolfs, Willem (1945), Huzarenlaan, Joppe (Geld), The Netherlands (N.J.)

Schroepfer, George J. (1958), Prof., San. Eng., Univ. of Minnesota, 280 Experimental Eng. Bldg., Minneapolis 14, Minn. (Cen. St.)

Streeter, Harold W. (1953), Box 192, R.R. 1, Old Indian Hill Rd., Cincinnati 27, Ohio (Fed.)

Wisely, W. H. (1956), Exec. Sec.-Ed., American Soc. of Civ. Eng., 33 W. 39th St., New York 18, N. Y. (Cen. St.)

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* Year of election to Honorary Membership and Member Association affiliation shown in parentheses.

ASSOCIATE MEMBERS

Airkem, Inc., 241 East 44th St., New York 17, N. Y., Rep. J. M. von Bergen.

Alpha Ltd., Nidau, Switzerland, Rep. H. Thurnheer, Vice-Dir.

American Cast Iron Pipe Co., Birmingham, Ala., Rep. J. W. MacKay, Vice-Pres., Sales.

American City Magazine, 470 Fourth Ave., New York, N. Y., Rep. Edgar J. Buttenheim, Pres.

American Concrete Pipe Assn., 228 N. LaSalle St., Suite 1033, Chicago 1, Ill., Rep. Howard F. Peckworth, Managing Dir.

American Pipe and Construction Co., P. O. Box 3428, Terminal Annex, Los Angeles 54, Calif., Rep. C. D. Herlihy, Gen. Sales Mgr.

American Well Works, 100 N. Broadway, Aurora, Ill., Rep. S. A. Karlin, Pres.

Armco Drainage & Metal Products, Inc. (Armco Steel Corp.), Middletown, Ohio, Rep. J. M. Robertson, Pub. Mgr.

Atlas Mineral Products Co., Mertztown, Pa., Rep. Robert T. Richey, Sales Mgr., Water and Sewer Materials.

B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I., Rep. G. W. Kelsey, Vice-Pres.

Brown Co., The, 150 Causeway St., Boston 14, Mass., Rep. Arthur R. Taylor, Gen. Mgr., Bermico Div.

Carter, Ralph B., Co., 192 Atlantic St., Hackensack, N. J., Rep. Donald A. Grenz.

Chain Belt Co., P. O. Box 2022, Milwaukee 1, Wis., Rep. R. T. Steindorf.

Chapman Valve Mfg. Co., 203 Hampshire St., Indian Orchard, Mass., Rep. John H. Sheehan, Sales Mgr.

Chicago Pump Co., 622 Diversey Parkway, Chicago 14, Ill., Rep. Milton Spiegel, Vice-Pres.

Combustion Engineering, Inc., Raymond Pulverizer Div., 1315 N. Branch St., Chicago 22, Ill., Rep. C. W. Gordon, Mgr.

DeZurik Shower Co., Sartell, Minn., Rep. David DeZurik.

Dorr-Oliver Inc., Havemeyer La., Stamford, Conn.

Dow Chemical Co., Technical Service and Development, Abbott Rd. Bldgs., Midland, Mich., Rep. Edward H. Bryan.

Elmco Corp., 301 S. Hicks Rd., Palatine, Ill., Rep. Paul O. Richter, Mgr., Central Div.

Engineering News-Record, 330 W. 42nd St., New York 36, N. Y., Rep. R. F. Boger.

Everson Mfg. Co., 214 W. Huron St., Chicago 10, Ill., Rep. R. B. Everson, Pres.

Fairbanks, Morse & Co., 3601 Kansas Ave., Kansas City, Kans., Rep. T. E. Woodruff.

Fischer & Porter Co., Hatboro, Pa., Rep. James F. Haskett, Gen. Mgr.

Flexible, Inc., 3786 Durango Ave., Los Angeles 34, Calif., Rep. Peter L. Ciaccio, Mgr.

Foxboro Co., Util. Ind. Div., Foxboro, Mass., Rep. Russell H. Babcock, Asst. Mgr.

General Electric Co., 1 River Rd., Schenectady 5, N. Y., Rep. E. O. Potthoff.

General Laboratory Supply Co., P. O. Box 2607, Paterson, N. J., Rep. I. T. Klein.

Gruendler Crusher & Pulverizer Co., 2915 N. Market St., St. Louis 6, Mo., Rep. William P. Gruendler.

Hardinge Co., York, Pa., Rep. M. C. Fleming.

Homestead Valve Mfg. Co., Box 348, Coraopolis, Pa., Rep. F. E. Schuchman.

Industrial Materials Co., Somerset St. & Trenton Ave., Philadelphia 34, Pa., Rep. John M. Riordan, Pres.

Inertol Co., Inc., 480 Frelinghuysen Ave., Newark 5, N. J., Rep. G. W. Rupp.

Infilco Inc., 901 S. Campbell Ave., P. O. Box 5033, Tucson, Ariz., Rep. H. W. Gillard.

Jeffrey Mfg. Co., Columbus 16, Ohio, Rep. S. L. Tolman.

Johns-Manville Corp., 22 E. 40th St., New York 16, N. Y., Rep. R. F. Orth.

Josam Mfg. Co., Michigan City, Ind., Rep. Leo N. Newman.

Keasbey & Mattison Co., Ambler, Pa., Asbestos Cement Pipe Dept.

Komline-Sanderson Eng. Corp., P. O. Box 257, Peapack, N. J., Rep. T. R. Komline, Pres.

Koppers Co., Inc., Tar Products Div., Pittsburgh 19, Pa., Rep. W. F. Marks.

Lakeside Eng. Corp., 222 W. Adams St., Chicago 6, Ill.

Link-Belt Co., Colmar Plant, Colmar, Pa., Rep. B. K. Hartman.

Lock Joint Pipe Co., E. Orange, N. J., Rep. F. F. Longley, Vice-Pres.

Minneapolis-Honeywell Regulator Co., Wayne & Windrim Aves., Philadelphia 44, Pa., Rep. F. L. Mascitti, Ind. Engr.

Morse Boulger Destructor Co., Sewage & Waste Div., 80 Fifth Ave., New York 11, N. Y.

Mueller Co., 512 W. Cerro Gordo St., Decatur, Ill., Rep. R. H. Morris, Gen. Sales Vice-Pres.

National Water Main Cleaning Co., 50 Church St., New York, N. Y., Rep. J. A. Frank, Pres.

Nichols Eng. & Research Corp., 3513 Hovey St., Indianapolis, Ind., Rep. R. W. Rowen.

Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago, Ill., Rep. James E. Kurtz.

Penn Instruments Division, Burgess-Manning Co., 4110 Haverford Ave., Philadelphia 4, Pa., Rep. R. A. McQuade.

Pittsburgh Coke and Chemical Co., P. O. Box 1645, Pittsburgh 30, Pa., Rep. J. G. Birch.

Pittsburgh-Des Moines Steel Co., Neville Island Branch, Pittsburgh 25, Pa., Rep. J. E. O'Leary.

Pittsburgh Equitable Meter Division, Rockwell Manufacturing Co., 400 N. Lexington Ave., Pittsburgh, Pa., Rep. H. Gottwald.

Preload Co., Inc., 211 E. 37th St., New York 16, N. Y., Rep. E. H. Thwaits, Vice-Pres.

Price Brothers Co., 1932 E. Monument Ave., P. O. Box 825, Dayton 1, Ohio, Rep. Harry S. Price, Jr.

Public Works Magazine, 200 S. Broad St., Ridgewood, N. J., Rep. W. A. Hardenbergh, Pres.

Robinson Clay Product Co., 24128 Knickerbocker Rd., Bay Village, Ohio, Rep. Wm. T. Jackman.

Roots-Connersville Blower Div. of Dresser Industries, Inc., 900 W. Mount St., Connersville, Ind., Rep. D. A. Johann, Vice-Pres.

Royer Foundry & Machine Co., 158 Pringle St., Kingston, Pa., Rep. Stanley S. Davies, Gen. Mgr.

Shahmoon Industries, Inc., 53 Liberty St., New York 5, N. Y., Rep. Frank Marold.

Simplex Valve & Meter Co., 7 E. Orange St., Lancaster, Pa., Rep. J. M. Hultz, Sales Mgr.

Smith, A. P., Mfg. Co., 545 N. Arlington Ave., E. Orange, N. J.

Smith-Blair, Inc., P. O. Box 666, South San Francisco, Calif.

Smith and Loveless, Inc., Lenexa, Kans., Rep. B. Alden Smith.

Stuart Corp., 516 N. Charles St., Baltimore, Md., Rep., Fred E. Stuart, Sr.

Technicon Controls, Inc., Saw Mill River Rd., Chauncey, N. Y., Rep. Ned L. Miller.

Vapor Recovery Systems Co., 2820 N. Alameda St., Compton, Calif., Rep. F. V. Long, Pres.

Walker Process Equipment, Inc., Aurora, Ill., Rep. J. D. Walker, Pres.

Wallace & Tiernan Co., Inc., 25 Main St., Belleville 9, N. J., Rep. T. T. Quigley.

Wastes Engineering, 305 E. 45th St., New York 17, N. Y., Rep. Alfred J. Houghton.

Water & Sewage Works, 185 N. Wabash Ave., Chicago 1, Ill., Rep. E. S. Gillette.

Waukesha Motor Co., Waukesha, Wis., Rep. H. Lemmer.

Western Machinery Co., 760 Folsom St., San Francisco 7, Calif., Rep. Wm. E. Galland.

Westinghouse Electric Corp., 3 Gateway Center, Pittsburgh 30, Pa., Rep. J. D. Witherspoon.

W-K-M Mfg. Co., Inc., Div. of ACF Industries, Inc., P. O. Box 2117, Houston 1, Tex., Rep. R. D. Butler.

Wood, R. D., Co., Public Ledger Bldg., Independence Square, Philadelphia 5, Pa., Rep. W. Davies.

Worthington Corp., Harrison, N. J., Rep. C. K. Hood, Vice-Pres.

Yeomans Brothers Co., 1999 N. Ruby St., Melrose Park, Ill., Rep. O. W. Burgoon, Pres.

SUPPLEMENTAL MEMBERSHIP DIRECTORY *

The last full membership listing, published in the March 1958 issue of THIS JOURNAL, gave the membership roster of Member Associations as of December 31, 1957. This supplemental listing, therefore, includes only the names and addresses of those who have been added to that previous listing as new or reinstated members during 1958 and therefore were not included in the main biennial listing.

Ake, Mortimer W., Chief Opr., Sewage Trt., 417 W. Grace St., Bedford, Ohio

Akers, Ward L., Eng. Stud., 1722½—4th Ave., Cedar Rapids, Iowa

Aldersey, E. C., A. M. I., Commr. of Works, 15 Dundas St., East, Trenton, Ont., Canada

Aldred, William Herbert, Design Engr., Eng. Div., Dept. of Pub. Works, 300 City-County Bldg., Nashville, Tenn. (Ky.-Tenn.)

Alexander, R. J., Deputy Dir., Oakland Co. Dept. Public Works, 550 S. Telegraph Rd., Pontiac, Mich.

Alfonso, Rafael Martinez, San. Engr., Box 1168, Rio Piedras, Puerto Rico

Allan, H. D., Gen. Sales Mgr., Worthington (Canada), Ltd., 2490 Bloor St., W., Toronto, Ont., Canada

Allen, Gerald S., 320 W. Owatonna St., Duluth, Minn. (Cen. St.)

Allen, Tip H., see Canton Municipal Util.

Alley, R. C., Salesman, Grinnell Co., Box 4719, Atlanta 2, Ga.

Allmon, Larry E., D-X Sunray Co., Box 831, Duncan, Okla.

Anderson, Donald R., 9 David Ross Rd., W. Lafayette, Ind. (Fla.)

Anderson, Harry L., Engr., Ayres, Lewis, Norris & May, 208 Detroit St., Saline, Mich.

Anderson, James D., Opr., Village, 118 W. James St., Dwight, Ill. (Cen. St.)

Anderson, Roger W., 1034 Birnam Woods Trail, Indianapolis 20, Ind. (Cen. St.)

Andrews, James R., Pres., Three A Builders, Inc., 1270 Maxwell Ave., Evansville 7, Ind. (Cen. St.)

Angermeier, Robert V., Owner, R. V. Angermeier Co., 3007 Muensterman Ave., Evansville, Ind. (Ky.-Tenn.)

Ansell, Harold, Pres., San. Dist., 13016 Euclid Ave., Garden Grove, Calif.

Antunes, A. Joseph, Reg. Engr., San. Eng., Equip. Dept., Link-Belt Co., 301 W. Pershing Rd., Chicago 9, Ill. (Cen. St.)

Apfel, George, Sales Engr., Graver Water Conditioning Co., 175 Snyder Ave., Ramsay, N. J.

Apley, Charles W., Sewage Trt. Opr., City Hall Annex, Pub. Works Dept., Haywood, Calif.

Appleton, Harold M., Assoc. Cons. Engr., R. H. Young & Assoc., Box 1026, Jackson, Miss.

Aprile, John J., Pres., Aprile Contracting Ltd., 120 Pharmacy Ave., Toronto 13, Ont., Canada

Armstrong, George, Jr., Chief Opr., Sewage Trt. Plt., 223 Cherry St., St. Marys, Ohio

Armstrong, Robert L., Western Sales Mgr., Henry Pratt Co., Chicago, Ill., 3445 W. Eighth St., Los Angeles 5, Calif.

Arnold, Gordon D., Partner, Southern Pipe Tool Co., Box 304, Fort Pierce, Fla.

Ash, John F., Mgr., Dye House, Spencer Mfg. Co., Oak Dr., Spencer, W. Va.

Ash, Col. Simon, 4210 Devon La., Sacramento 21, Calif. (Fed.)

Assenzo, Joseph R., Cons., Dept. of Pub. Health & San. Science, School of Eng., Univ. of Oklahoma, Norman, Okla. (N. Eng.)

Astacio, Felix F., Health Officer, Milk Inspection, Dept. of Health, Rio Piedras, Puerto Rico

Ausman, E. M., Gen. Mgr., George Kent (Canada) Ltd., 389 Horner Ave., Toronto 14, Ont., Canada

Austin, LeRoy Morris, Opr., Sewage Trt. Plt., 721 N. Fancher Ave., Mt. Pleasant, Mich.

Ayers, William T., Ayers San. & Eng., Box 175, Clermont, Ind. (Cen. St.)

Aylward, Walter W., Plt. Opr., Pratt & Whitney Aircraft Plt., Rt. 4, Juno Beach, Riviera Beach, Fla.

Baba, George J., Asst. Engr., Anniston Water Dept., 131 W. 11th St., Alexander City, Ala.

Babbitt, Charles C., Supt., Pub. Util., 424 Coolbaugh St., Red Oak, Iowa

Babcock, John, City Engr., City Hall, Watertown, S. Dak.

Babcock, Russell H., The Foxboro Co., Foxboro, Mass. (N. Eng.)

Bachteal, Robert M., San. Engr., McNamee, Porter & Seeley, 2415 Yorkshire Rd., Ann Arbor, Mich.

Badgett, Charles O., Chem. Engr., Industrial Nucleonics Corp., 928 Caniff Pl., Columbus 21, Ohio

Bailey, Allen C., Head, Water Dept., Eastman Kodak Co., Util. Div., Kodak Pk. Works, Rochester 4, N. Y.

Bailey, Irvan E., Opr., Sewage Plt., 4401 Aubrey White Pkwy., Spokane, Wash. (Pac. N. W.)

Bailey, William M., Cons. Engr., Henningson, Durham & Richardson, 2962 Harney, Omaha, Nebr.

Baily, Alferd E., Engr., The Chester Engrs., 148 Ryan Dr., Pittsburgh 20, Pa.

Baker, James C., Mgr., Harris Co. Water C & I Dist. 20, 4020 Banner Dr., Houston 15, Tex.

Baker, Michael, Jr., Inc., Att.: Arthur C. Miller, Vice-Pres., Box 9997, Northside Sta., Jackson, Miss.

Baker, Robert, Chem., Wallace & Tiernan, Inc., 18 Colonial Terr., Pompton Plains, N. J.

Balch, G. E., Chem., Ind. Wastes, Barrett Div., Allied Chemical Corp., Sunbury, Pa.

Balden, A. R., Staff Engr., Chrysler Corp., 12800 Oakland, Detroit 31, Mich.

Bale, Harvey E., Asst. Engr., Albright & Friel, Inc., 18 S. 50th St., Philadelphia, Pa.

Bandeen, Kenneth, San., Central Mich. Health Dept., 610 S. College, Mt. Pleasant, Mich.

Bandy, Charles L., see Fairbanks, Morse & Co.

Banks, Robert H., Rep., Pomona Terra-Cotta Co., Greensboro, N. C.

Barksdale, William D., Supt., Weirton San. Bd., 1618 Main St., Weirton, W. Va.

Barnes, Lee, Opr., Sewage Trt. Plt., Clinton Twp., 23880 Glenwood, Mt. Clemens, Mich.

Baron, A. R., Engr., Dist. 6, Div. of Health, Hwy. 67, S., Poplar Bluff, Mo.

Barrens, Richard G., Eng. Asst., Ontario Water Resources Comm., Rm. 24, 30 Grosvenor St., Toronto, Ont., Canada

Barron, Q. D., Asst. Plt. Engr., Raytheon Mfg. Co., Bristol, Tenn. (Ky.-Tenn.)

Barron, William, Shift Opr., 141 W. Bacon St., Hillsdale, Mich.

Barrows, H. Lyndon, Dir. of Sales, Jones Chem., Inc., 19200 N. W. 10th Ct., Miami 69, Fla.

* Member Association affiliation shown in parentheses in all cases where the affiliation is not immediately evident from the member's address.

Bartlett, Isaiah D., Chem., Util. Dept., Raleigh, N. C.

Bates, Kenneth L., 522 Nesbit Ct., Garland, Tex.

Bauer, Carl, Opr., Sewage Trt. Plt., 127 S. Water, Vassar, Mich.

Baxter, Alfred G., Dist. Mgr., Stege San. Dist., 6318 Manila Ave., El Cerrito, Calif.

Baxter, LaVerne, Opr., Sewage Trt. Plt., Box 70, Paw Paw, Mich.

Beach, Glenn L., Plt., Supt., 801 W. Live Oak Ave., De Funiak Springs, Fla.

Beall, Charles R., Jr., Chemist, 1 Berkeley Rd., Chapel Hill, N. C. (S.C.)

Bean, Richard W., Supt., 98 Locke Rd., Hampton, N. H. (N. Eng.)

Beard, Wendell, Cons. Engr., 308 Rusk Bldg., Houston 2, Tex.

Beatty, H. M., Jr., N.W. Sales Rep., Hooker Electrochemical Co., Box 1656, Tacoma, Wash. (Pac. N. W.)

Beauchamp, R. C., Sales Engr., Pacific Pumping Co., 526 N. W. Broadway, Portland, Ore. (Pac. N. W.)

Bednar, Steve, Sales Rep., Pittsburgh Coke & Chem., 7750 W. 61st Pl., Chicago, Ill. (Mich.)

Beecher, Jack, Plt. Opr., City Of Pacifica, 1212 County Rd., Sharp Park, Calif.

Beindit, Thomas, Supt., New Haven Sewage Trt. Plt., 7073 Palms Rd., Fair Haven, Mich.

Bejcek, Otto J., Div. Rep., Wallace & Tiernan Inc., 1713 S. California Ave., Monrovia, Calif.

Bell, Albert G., see Mt. Vernon Sewer Dist.

Bell, J. G., Cons. Engr., Kirkham, Michael & Assocs., 618½ St. Joe St., Rapid City, S. Dak.

Bell, John Martin, Stud., 340 W. Stadium Ave., W., West Lafayette, Ind. (Cen. St.)

Bell, John W., Sales Engr., Dravo Corp., 1485 Bayshore Blvd., San Francisco 24, Calif.

Bell, Pete, Opr., Sewage Trt. Plt., Lewis, Kans.

Bell, Ray C., Opr., U. S. Naval Sta., 1647 Charon Rd., Jacksonville 5, Fla.

Belyea, George A., Salesman, Nelson Chem. Co., 12345 Schafer, Detroit, Mich.

Bement, Alvah, Opr., Sewage Disposal Plt., 837 H St., Salida, Colo. (Rky. Mtn.)

Bennett, C. L., Mgr., Boro. of Poole Sewage Trt. Works, Sopers La., Waterloo, Poole, Dorset, England (ISP)

Bennett, Edwin R., Washington Univ., St Louis, Mo.

Bennett, George Edmund, Box 488, Loring Air Force Base, Maine (Cen. St.)

Bentley, W. D., Cons. Engr., Forrest & Cotton, 6915 Meadow Lake Ave., Dallas 14, Tex.

Berg, R. L., Continental Oil Co., Box 2523, Billings, Mont.

Berger, Herbert F., Reg. Engr., Natl. Council for Stream Impr., Box 8786, L.S.U., Baton Rouge 3, La. (Fla.)

Bergman, B. S., Cons. & Chartered Civil Engr., 108–110 Transafrica, 21 Wolmarans St., Braamfontein, Johannesburg, S. Africa (ISP)

Bergstrom, Andrew R., Mgr., Plt. Facilities Div., The Martin Co., MP 124, Orlando, Fla.

Berkeley, H. C., Gen. Mgr., Pump Div., Sydnor Pump & Well Co., Inc., 1305 Brook Rd., Box 1476, Richmond, Va.

Berkoben, Darrell S., see Opalco Lab., Inc.

Bernardi, Donald R., 1002—15th St., Tell City, Ind. (Cen. St.)

Berschauer, Walter, Dist. Engr., Washington Dept. of Health, 10140 Holman Rd., Seattle 33, Wash. (Pac. N. W.)

Bespalow, E. F., Vice-Pres. & Chief Engr., Choctaw, Inc., Box 2057, Memphis 2, Tenn. (Miss.)

Bess, F. D., Maint. Engr., Union Carbide Chem. Co., Institute Plt., Box 2831, Charleston 30, W. Va.

Besthoff, Anthony W., Tech., Faesy & Besthoff, Inc., 25 E. 26th St., New York 10, N. Y. (Pa.)

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Van Nostrend, Maitland, Supt., Wastes Trt. Plt., American Cyanamid Co., RFD, Skillman, N. J.

Vance, Clarence G., Div. Mgr., Edison Sault Electric Co., Mackinac Island, Mich.

Vandaveer, R. L., Vice-Pres., Allied Analytical & Res. Lab., 3833 Cedar Springs, Dallas 19, Tex.

Vaudreiul, Norman, Pres., JU-NO Supply Co., Box 1116, Clearwater, Fla.

Vaudry, Calvin, Cons. Engr., J. T. Banner & Assoc., 1432 Second St., Brookings, S. Dak.

Vaughn, Donald R., San. Sales Engr., Dorr-Oliver, Inc., 123 Sylvan Knoll Rd., Stamford, Conn. (Pa.)

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Velez, Luis A., Civil Engr., Asst. Chief, Urban Proj. Div., P. R. Aqueduct & Sewer Auth., Box 7066, Bo. Obrero Sta., Santurce, Puerto Rico

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Wade, Foy, Process Engr., Ashland Oil & Refining Co., Box 391, Ashland, Ky. (Ohio)

Wagner, William C., Main Opr., Sans Souci Water & Sewage Co., 2156 Belinda Circle, Jacksonville, Fla.

Wakefield, Clarence N., Jr., Sales Engr., Amercoat Corp., Box 2977, Jacksonville 3, Fla.

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Wolf, J. B., Dir., Eng. & Res., Van Arsdale Labs., Inc., 216 N. Fifth St., Minneapolis 3, Minn. (Pac. N. W.)

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Wood, Roy A., Water Supt., Dill City, Okla.

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Zissette, Robert J., Supvr., Util. Dept., Ft. Lauderdale, Fla.

Zoeller, August, Plt. Supvr., Nassau Co. Dept. of Pub. Works, 31 Quincy St., Merrick, L. I., N. Y.

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Zuehl, Leonard G., 1027 Frank Hall Ave., Albert Lea, Minn. (Cen. St.)

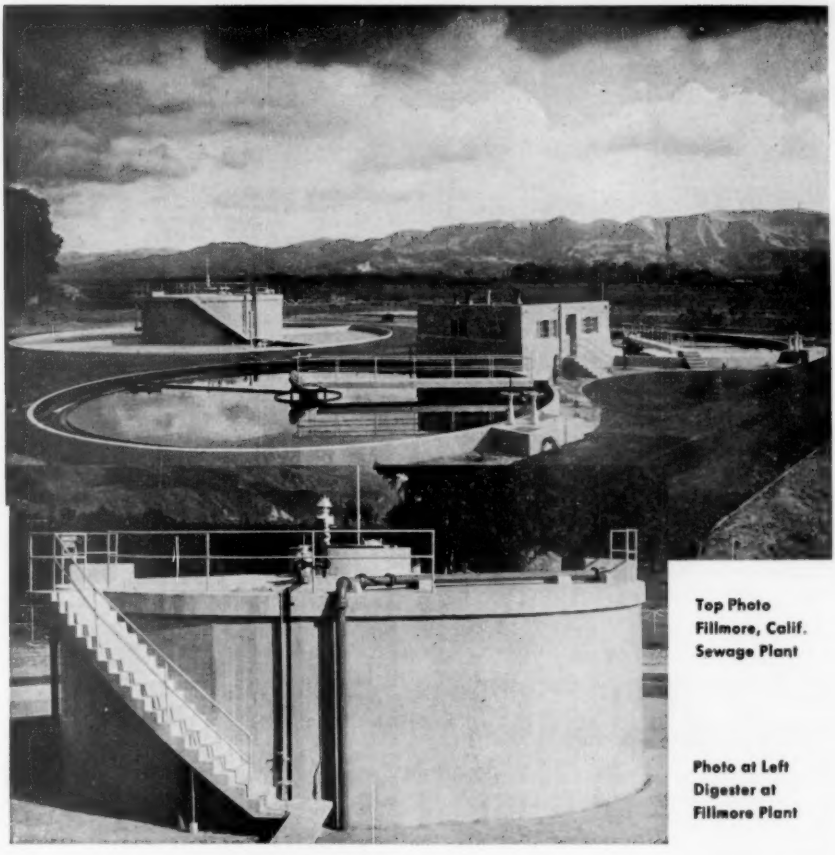

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Photo at Left
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Proceedings of Member Associations

CANADIAN INSTITUTE ON SEWAGE AND SANITATION

The 25th Annual Congress of the Canadian Institute on Sewage and Sanitation was held at the Chateau Frontenac, Quebec City, Que., Oct. 20–22, 1958. The registration was 586, the second highest on record and the luncheons and banquets were extremely well attended.

The papers read at the meeting were judged to be of a high standard and covered subjects of current interest. In addition, the guided discussions were most helpful in making an interchange of information possible. Among the papers and discussions of interest to those in the waste treatment works field were:

"Guided Discussion: Maintenance of Sewers," directed by N. G. McDonald, Consulting Engineer, Toronto, Ont.

"Synthetic Detergents and Sewage Treatment," were discussed by E. H. Baldock, Assistant Director of Water Purification and Sewage Treatment Laboratories, Toronto, Ont., and J. David Justice, Assistant Research Director, Lever Brothers Co., Ridgewood, N. J.

"Modern Developments in the Activated Sludge Process," by Dr. C. N. Sawyer, Metcalf and Eddy, Boston, Mass.

"Flash Drying and Incineration System for Disposal of Sewage Sludge," by R. D. Nickerson, Combustion Engineering, New York, N. Y., and T. D. McMurray, Combustion Engineering-

(Continued on page 112a)

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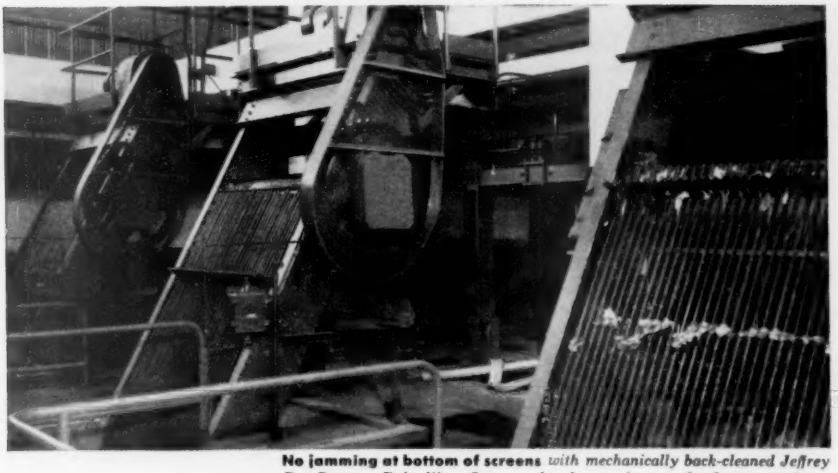

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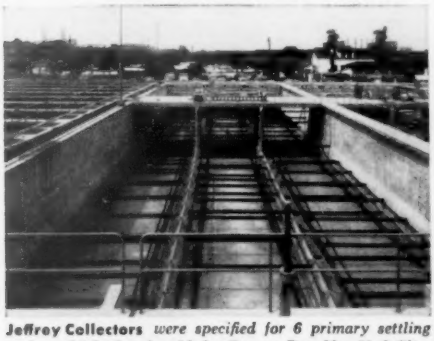

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"Drying and Combustion," by Mark Owen, Nichols Engineering and Research Corp., Indianapolis, Ind.

"Application of the Atomized Suspension Technique to the Treatment of Sanitary Sludges," by Drs. W. A. Garvin and Jan Dlouhy, Pulp and Paper Research Institute of Canada, Montreal, Que.

"The Zimmermann Process," by F. J. Zimmermann, Salvo Chemical Corp., Rothschild, Wis., and G. A. Rohlich, University of Wisconsin, Madison, Wis.

"Guided Discussion—Acceptance of Industrial Wastes into Public Sewers," under the chairmanship of W. L. Wardrop, Consulting Engineer, Winnipeg, Man.

"Developments in the Mechanical Removal of Solids from Sewage and Industrial Wastes," by D. B. Redfern, Proctor and Redfern, Consulting Engineers, Toronto, Ont.

An interesting question and answer period was moderated by Dr. A. E. Berry, General Manager, Ontario Water Resources Commission, Toronto, Ont.

The Bedell Award was presented to Clarence S. Anderson, Commissioner of Works, South Porcupine, Ont. The Hatfield Award went to Charles Hicks, Superintendent, Sewage Disposal Plant, Cobourg, Ont.

Officers for the 1958–59 year are:

President: James F. MacLaren, Toronto, Ont.

Vice-President: W. L. Wardrop, Winnipeg, Ont.

Director: C. G. R. Armstrong, Windsor, Ont.

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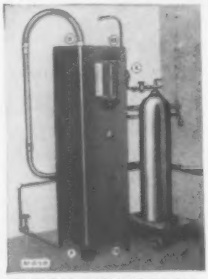
(*Continued on page 114a*)

CHLORINE GAS CONTROL EQUIPMENT



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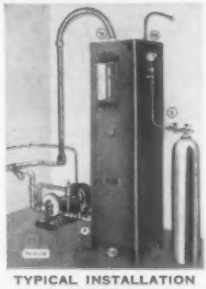
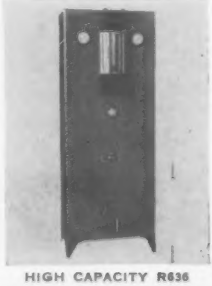


TYPICAL INSTALLATION WITH BOOSTER PUMP ON WATER SUPPLY



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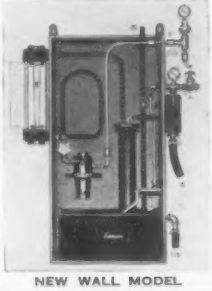

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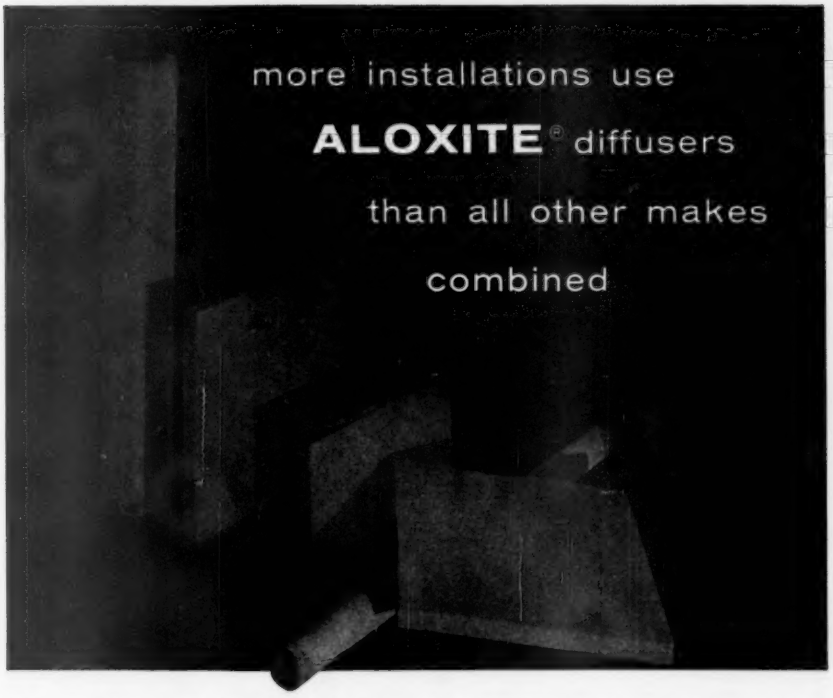

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NEW ENGLAND SEWAGE AND INDUSTRIAL WASTES ASSOCIATION

The 30th Annual Meeting of the New England Sewage and Industrial Wastes Association was held at the Statler-Hilton Hotel, Hartford, Conn., Nov. 5–6, 1958. Total attendance was 230, comprised of 204 members, 6 guests, and 20 ladies.

At the technical session the following papers were presented:

"Photographic Exploration of Sewer and Drain Problems," by Malcolm Woronoff, Underground Photographic Surveys.

"Application of Photographic Exploration in Litigation," by Francis A. Obert, Metcalf and Eddy, Boston, Mass.

"Unusual Problems in Modern Sewer Construction," by A. W. Sweeton, L. A. Fagan, and J. J. Malloy, Metropolitan District Commission, Hartford, Conn.

"Recent Digester Operation Improvement at Hartford," by George Lebetkin and E. A. Kowsz, Metropolitan District Commission, Hartford, Conn.

"Design and Operation of Small Activated Sludge Plants," by Ross E. McKinney, Massachusetts Institute of Technology, Cambridge, Mass.

"Overflows of Sanitary Sewage from Combined Sewerage Systems," by Thomas R. Camp, Camp, Dresser and McKee, Boston, Mass.

At the annual luncheon Federation President W. D. Hatfield spoke briefly on Federation affairs and presented the first sewage plant operator certificates to those who had qualified under the New England voluntary certification program. Following the presentation, Metropolitan District Manager, William A. D. Wurts spoke on "The Metropolitan District at Hartford County."

(*Continued on page 116a*)

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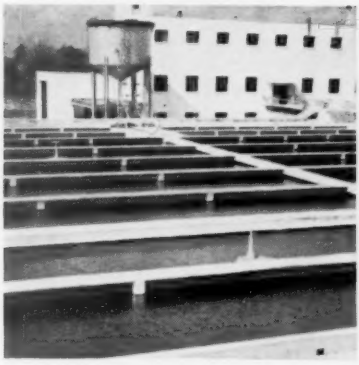

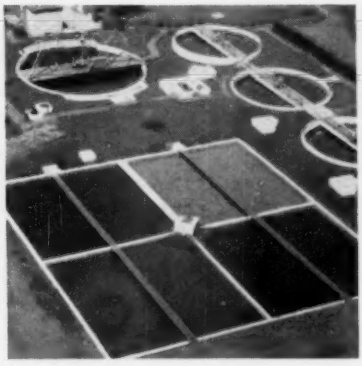

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Secretary-Treasurer: Earl R. Howard, Hartford, Conn.

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Secretary-Treasurer

SOUTH CAROLINA WATER AND SEWAGE WORKS ASSOCIATION

The Annual Meeting of the South Carolina Water and Sewage Works Association was held at the Jefferson Hotel, Columbia, S. C., Nov. 14, 1958.

Interesting papers were presented on "Experimental Treatment of Textile Finishing Wastes with Municipal Sewage at Greenville, S. C.," by Frank M. Gibson, Chemist, Greenville, S. C., and "Observations on Effects of Nutrients in Determining Stream BOD," by staff members of the South Carolina Water Pollution Control Authority.

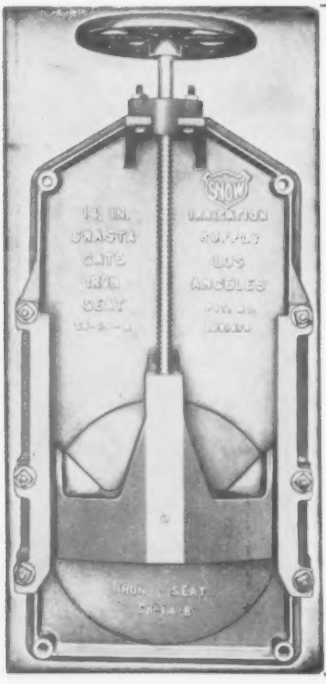
Following the annual luncheon, Federation Past President K. S. Watson presented the Bedell Award to T. E. Robertson, Superintendent, Spartanburg Metropolitan District, Spartanburg, S. C. The Hatfield Award was presented to Frank M. Gibson, Chemist, Greater Greenville Sewer District, Greenville, S. C.

Officers elected for 1958–59 were:

Chairman: O. M. Fuller, Union.
Vice-Chairman: Carl C. Lanford, Greer.
Secretary: Robert N. Bowen, Columbia.
Treasurer: T. P. Anderson, Columbia.
Director: J. D. Lesslie, Fort Mill.

ROBERT N. BOWEN,
Secretary

(*Continued on page 118a*)



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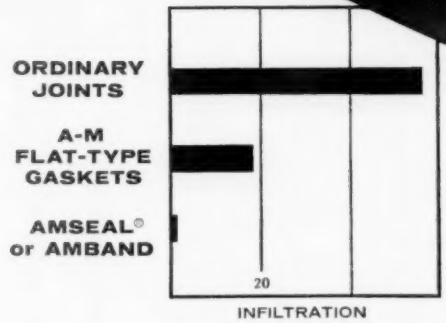

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WEST VIRGINIA SEWAGE AND INDUSTRIAL WASTES ASSOCIATION

The 12th Annual Meeting of the West Virginia Sewage and Industrial Wastes Association was held jointly with the Annual Meeting of the West Virginia Section, American Water Works Association. The meeting was held at the Daniel Boone Hotel, Charleston, W. Va., Oct. 23–24, 1958. Registration totaled 209 and more than 200 members and guests attended the banquet.

The technical program was well arranged with excellent papers and good participation. Among the papers of interest to sewage and industrial wastes personnel and municipal officials were:

"A New Concept in Sewer Pipe Classification," by H. Sandt, Johns-Manville Sales Corp., New York, N. Y.

"Magnetic Flow Meters," by E. J. Jaeger, Fischer and Porter Co., Hatboro, Pa.

"Kanawha River Survey," by Lyhle Gillenwater, State Water Commission, Charleston, W. Va. This was followed by a panel discussion of the Survey.

"Wastes Distribution by Elemental Analysis," by F. R. Smith, University of Kentucky, Lexington, Ky.

"Training for Operation of Automatic Equipment," by William Firth, Infilco, Inc., Roanoke, Va.

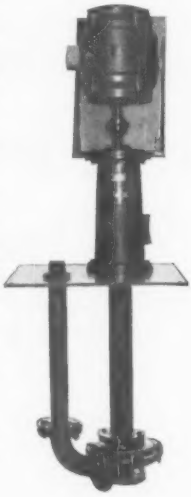
"Radioactive Materials in Water," by Harry Kramer, USPHS, Cincinnati, Ohio.

"Water—A Vital Problem Today," by Walter C. Gumbel, Monongahela Power Co., Fairmont, W. Va.

"Progress on Federal Aid," by Bern Wright, State Water Commis-

(*Continued on page 120a*)

This NAGLE PUMP is a "relief" around Sewage Treatment Plants!



This Nagle type "CWO-C" vertical shaft sewage sludge pump is a "relief" to sewage plant engineers because it gives trouble-free service and is easy to maintain, all parts being readily accessible.

It has a non-clogging impeller, designed specifically to handle sludge or abrasive slurries. All parts in contact with material being pumped are of abrasion resistant alloy. No bearings below the floor plate—no rubbing contact between revolving and stationary parts below this level.

Available in sizes from 1" to 16", capacities to 8000 GPM, and heads in some cases up to 230'. The type "CDO-C" is similar, but is for dry pit operation.

Nagle pumps available for handling raw and digested sludge, filter bed sand transfer, grit pumping, chemical pumping and sump pumping.

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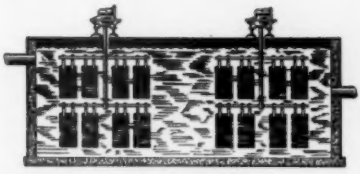
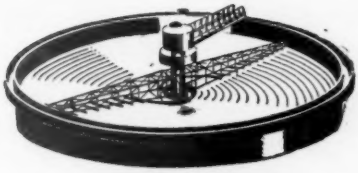
Especially suited for limited spaces or where sludge delivery is desired at one end of the tank. A traveling scraper and skimmer carriage removes settled solids from the tank bottom and scum from the top.



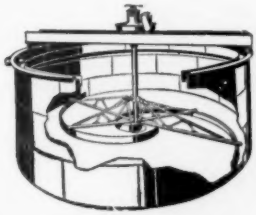
FLOCCULATING UNITS

Slowly rotating paddles on vertical shafts bring the small flocs into contact to form larger masses and hasten precipitation.



CIRCULAR CLARIFIERS

Hardinge Circular Clarifiers are available in sizes up to 200′ diameter, either center-column or beam supported for steel, concrete, wood or tile tanks. Sludge scrapers remove settled solids rapidly through central underflow discharge.

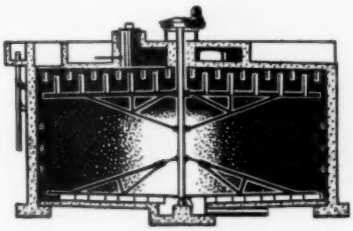


"AUTO-RAISE" THICKENERS

For removal of fine suspended solids from supply water, waste water and sewage. "Auto-Raise" mechanism prevents scraper breakage. Manual or power raise supplements "Auto-Raise." Replaceable ring-type ball bearing support for rotating mechanism. Spiral rakes for maximum underflow density.

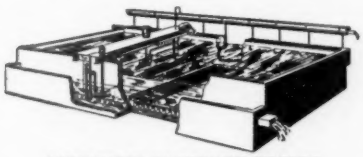
HYDRO-CLASSIFIERS

A large-volume classifier for rapid separation of coarse and fine suspended solids. Frequently used for by-product recovery from waste water.



DIGESTERS

Sludge scrapers and scum breaker arms prevent scum accumulation, insure uniform gas production. Emit a dense digested sludge.



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sion, Charleston, W. Va.

"Sewer Maintenance," by Harry Pitts, Parkersburg, W. Va.

"Operator Reports," by G. O. Fortney, State Department of Health, Charleston, W. Va.

Federation affairs, responsibilities, and opportunities were discussed by Federation Vice-President Mark D. Hollis.

The following officers were elected:

President: Harry W. Pitts, Jr., Parkersburg.
First Vice-President: Rex Pierson, Charleston.
Director: Paul T. Arbuckle, Nitro.
Secretary-Treasurer: Glen O. Fortney, Charleston.

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pH Meter—A lightweight, pocket pH meter with combination glass and reference electrode and 36-in. lead (Figure 1) is available from Scientific Instruments Division, Beckman Instruments, Inc., Fullerton, Calif.

FIGURE 1.—Pocket pH meter with combination glass and reference electrode.

Flow Meters—A 22-page bulletin gives basic information and theory on the selection, sizing, and installation of the various types of flow meters.—Bulletin F1607, The Bristol Co., Waterbury 20, Conn.

Test Tube Plugs—Disposable plugs of non-absorbent, resilient, sponge-like plastic are available for test and culture tubes.—Scientific Products, Division of American Hospital Supply Corp., 1210 Leon Place, Evanston, Ill.

Flexible Pipe and Fittings—Flexible pipe and expansion joints for pressure, vacuum, or combined pressure and vacuum service and offered in sizes from ½ to 72 in. in diameter, with either full-faced flanges or enlarged slip-over pipe ends.—General Rubber Corp., Summit and Atwood Sts., Tenafly, N. J.

Venturi Meter—A twin-throat Venturi meter has been marketed recently. This meter produces higher differential pressure or lower head loss in shorter laying length than other types. The low pressure is taken from a hydraulically streamlined body instead of from a wall in a way in which a higher differential is obtained without materially changing the energy conversion in the tube, while the head loss remains practically the same. A full range of sizes is available.—Bulletin 1021, Infilco, Inc., P. O. Box 5033, Tucson, Ariz.

Package Treatment—Bulletin 7315 covers a package-type wastewater treatment unit, called "Comple-Treator." A high degree of treatment for a maximum of 150 persons is provided.—Dorr-Oliver, Inc., Barry Place, Stamford, Conn.

Gas-Fired Boilers—Large cleanout doors at each end and "H" block boiler sections for ease of cleaning are featured in gas-fired boilers rated from 600,000 to 5,400,000 Btu input per hour.—Peerless Heater Co., Boyertown, Pa.

Pipeline Fittings—Smith, Blair, Inc., has opened a new assembly plant, warehouse, and regional sales office in Henderson, Texas, for service to users of their pipeline couplings, connections, and clamps in the midwest, south, and southwest areas.

Underground Pumping Station—A completely prefabricated underground pumping station is described in an 8-page bulletin.—Zimmer and Francescon, P. O. Box 359, Moline, Ill.

Flume Meter—A new meter is available for measurement of flow through Parshall flumes, utilizing a float and transmitting device.—Burgess-Manning Co., Penn Instruments Division, 4110 Haverford Ave., Philadelphia 4, Pa.

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(Continued through page 129a)

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INDEX TO ADVERTISERS

	Page
American Concrete Pressure Pipe Association	94a, 95a
American-Marietta Company	117a
American Well Works	96a
B-I-F Industries, Incorporated	Inside Front Cover
Carborundum Company (Refractories Division)	113a
Carter, Ralph B., Company	90a
Cast Iron Pipe Research Association	88a, 89a
Chicago Pump Company	79a
Combustion Engineering (Raymond Division)	83a
Dorr-Oliver Incorporated	108a
Everson Manufacturing Corporation	112a
Flexible Incorporated	132a
General Chemical Division (Allied Chemical Corporation)	115a
Graver Water Conditioning Company	93a
Hardinge Company, Incorporated	119a
Inertol Company, Incorporated	100a
Infilco Incorporated	87a
Iowa Valve Company (Subsidiary of James B. Clow and Sons)	103a
Jeffrey Manufacturing Company	111a
Johns-Manville	98a, 99a
Lakeside Engineering Corporation	92a
Link-Belt Company	97a
Lock Joint Pipe Company	Inside Back Cover
Nagle Pumps, Incorporated	118a
National Clay Pipe Manufacturers, Incorporated	101a
National Water Main Cleaning Company	105a
Pacific Flush Tank Company	81a
Pfaudler Permutit Incorporated	102a
Portland Cement Association	107a
Simplex Valve and Meter Company (Subsidiary of Pfaudler Permutit Incorporated)	85a
Snow Gates and Valves	116a
Stebbins Engineering and Manufacturing Company	104a
Stewart, W. H., Incorporated	114a
Vapor Recovery Systems Company	109a
Vulcan Materials Company	91a
Wallace and Tiernan Incorporated	Back Cover
Webster Manufacturing, Incorporated	106a
Western Machinery Company	110a, 120a
Zimmer and Francescon	120a

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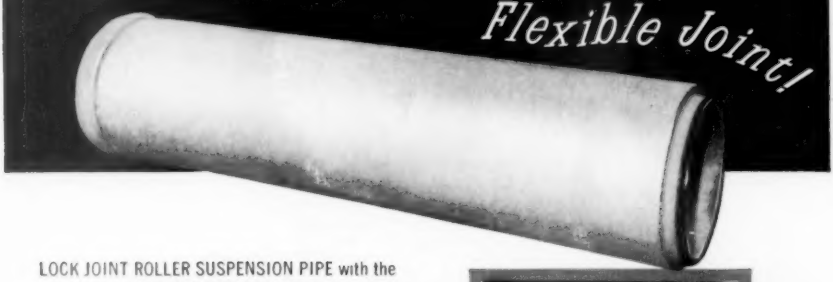

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